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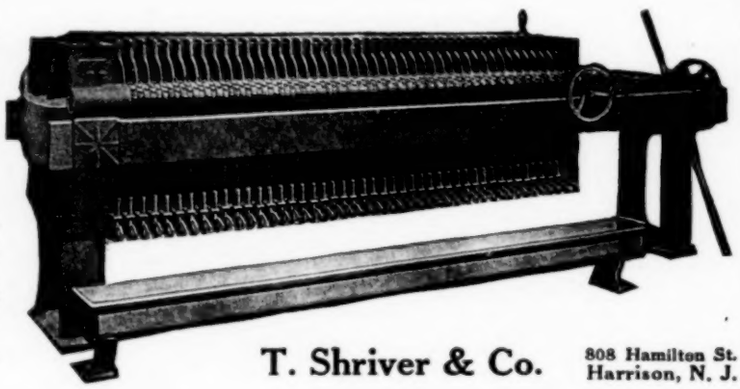

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In the Interest of Education in Mathematics

IT IS PROFITABLE in more ways than one to study the reports of the Rockefeller Foundation and the General Educational Board. The literary style of President VINCENT of the Foundation, whereby, in the simplicity of consummate art, he tells, in the fewest possible words, of their herculean efforts in battle against disease and for health all over the world, is an inspiration in itself. And again, to know that while so large a part of the world seems to have lost its ideals and to have gone loose in thinking and in character, there are those who are diligent in well-doing without trying to make a fuss about it is a still greater inspiration. In his report of the General Educational Board Dr. BUTTERICK explains their activities with the greatest praise for the generosity of others, but with such modesty for the Board's own immense disbursements as to give the impression that they really had to do it and that he hoped you would excuse them for having to acknowledge it.

One item in explanation of an appropriation for a committee of the Mathematical Association of America deserves mention here. A great many of our chemists and chemical as well as other engineers are short in their mathematics. Even among those who have studied and have passed their examinations, the understanding and the philosophy of mathematics is often lacking. Mathematics is too often taken like Latin—to be studied "to train the mind" and then forgotten. By far too much is known by formula only. Now this committee composed of professors and instructors from colleges and secondary schools present a report which is reprinted in full in the report of the General Educational Board, and it is well worth reading. They believe that both in colleges and secondary schools the mathematical curriculum is in need of reformation. It should be adapted to the needs of the world of today and tomorrow instead of the world of yesterday. It is held that secondary school mathematics may prepare the student for his life work as well as for college courses without lowering the standard of scholarship. In regard to algebra, for instance, they say: "Our elementary algebra is, in theory and symbolism, substantially what it was in the seventeenth century. The present standards of drill work, largely on non-essentials, were set up about fifty years ago. The few lines of application of algebra to nominally practical questions found in our college entrance examinations are mere variants of problems that are centuries old and often represent only remotely any real conditions of today. A considerable number of teachers, both in the secondary schools and in the colleges, believe that the amount of time spent by pupils on abstract work in difficult problems in division, factoring, fractions, simultaneous equations, radicals, etc., is excessive; that such work leads to nothing important in the science, and adds but little to facility in the manipulation of algebraic forms." They believe that the more difficult and abstract portions of such work could be replaced by work of a much more profitable nature, such as the real uses of algebra, the applications of intuitive geometry, modern methods of computation, and the significance of trigonometry. Among specific elementary topics which have of recent years been suggested and whose availability in this connection should receive careful and open-minded consideration may be mentioned the mathematics of business and finance, the graphic representation of facts, mechanical drawing and perspective, elementary notions of statistics, the use of logarithms (and of tables in general), the slide rule, elementary principles of surveying with field work, etc. It is also felt by many that, just as the mathematical work in the schools has in the past been enriched by the continual introduction of principles previously regarded as too advanced, the time has come to give careful consideration to the question whether in the more advanced secondary school courses the work could not be made more valuable, more vital and more significant by the introduction of the elementary principles of analytic geometry and calculus, and of projective geometry. It is urged that the elementary ideas and processes of these subjects are less difficult than some of those now included in our courses in advanced algebra and solid geometry, and much more interesting and significant.

"It is urged by many friendly critics that, instead of giving a student a good all-round idea of what mathematics means and of its general range of application, our present secondary school courses are too abstract, often uninteresting except to the mathematically inclined, and not as valuable as they might be as an aid to college work in general or to life work for those who enter at once into their careers. These are not the opinions of the extremists in the schools of education; they are the opinions that are held by a large number of college professors and secondary school teachers. They are not the opinions of destructionists, but of those who have well-defined ideas of a modern, living, scholarly course in mathematics to replace what they believe is rapidly becoming obsolete."

There is still more to the same effect, and we wish we had space for it. Suffice to say that the enlightened teachers believe that they can begin mathematics in secondary schools as a live study, and by extending it into the first two years of college courses, give the subject that reality and vitality to which it is entitled.

We congratulate the teachers on the support that they are receiving in this good work and we congratulate the General Educational Board on its wisdom. It looks like light ahead.

Patents Viewed As Contracts

SOME months ago, in our issue for Sept. 22, 1920, we published an article by CHESLA C. SHERLOCK on "The Value of Patents." The author made an admirable presentation of the position of the patentee as far as his monopolistic powers are concerned. He quoted one court as saying, "Within his domain he [the patentee] is czar." There is, however, another important phase of the matter which should not be overlooked—namely, the contract relation of the patentee to the public. By very reason of the fact that the patentee is czar within his domain, and because of the monopolistic powers conferred upon him, "the acts of legislatures which prescribe the limit and conditions of the patent privilege and the decisions of the courts in interpreting and applying such legislative acts relate to its contract character alone." Our authority is found in section 41 of Robinson on Patents.

In other words, a patent is primarily a contract between an inventor and the public, a contract by the terms of which the patentee is obliged distinctly to state and clearly point out in exact terms just wherein his invention lies and of what it consists. This duty to the state is explicitly imposed upon the patentee. Curtis says: "The truth is, a patent should be construed as what it really is, in substance—namely, a contract or bargain between the patentee and the public upon those points which involve the rights and interests of either party. These points relate to the extent of the claim and to the intelligibility of the description for the purposes of practice."

Courts and legal writers in treating this subject have consistently recognized the principle that patent law rests upon a contract basis. Hence, because of the broad—not to say monopolistic—character of the grant to the patentee, he is held by the courts strictly to the scope of his patent as distinctly claimed and clearly pointed out in the claims.

Doctor, Teacher, Chemist, Preacher

IN THE *Transactions* of the Institution of Mining and Metallurgy of Great Britain for the years 1917-18 there is a necrological note of interest. It refers to one of their members born in Canada in 1837, the son of a Canadian surgeon. As a young man the late member planned to follow his father's footsteps, studied medicine in Canada and Germany, but on returning to Quebec he became professor of chemistry at Morrin College, Quebec, instead of practicing his avowed profession. In the end neither medicine nor chemistry could hold his attention against what seemed a greater call, for he returned to Europe, this time to Scotland, where he matriculated and took the course in theology at the University of Edinburgh. In 1875, when he was thirty-eight years of age, he received his license to preach in the Presbyterian Church. He was not ordained in any pastorate, however, because just at that time his father's affairs, owing to unfortunate investments, called for his immediate presence in Canada again. He therefore returned and addressed himself to the problem of saving his father's property, but in order to provide for his own sustenance he became superintendent of an insane asylum, thus reverting in part to the practice of medicine again. Now, among the old doctor's investments that had gone wrong was the Harvey Hill copper mine in Quebec, which could never be developed into a great success—but it gave the junior doctor-clergyman both interest in and experience on the subject of copper mining and the treatment of copper ores. His work along this line led to his engagement, as a man of forty, to become superintendent of a chemical copper extraction plant in Pennsylvania where Western matte was treated. In 1880, being then forty-three years of age, he went West to pay a visit to a recently opened mine in Arizona, where he recognized a great future for the industry. Then he returned East and interested some of the partners of a leading metal firm in the enterprise, but endured four or five years of great uncertainty and anxiety before the tide turned. After this there followed nearly forty years of immense personal and professional success in the development of the American copper mining and smelting industry, in which he was recognized as a great leader. The metal firm to which we refer was PHELPS, DODGE & CO., and the man whose history we have been sketching was none other than the late Dr. JAMES DOUGLAS.

An Appropriate Time For Investigations

WHEN times are good and material costs are low, it is easy to make money in industry. The real test of operating efficiency comes only when the operating margin is small or when costs advance sharply with reference to market demands for products. During the war period (and no economic discussion can fail to mention the war) chemical industry grew like Jack's beanstalk of fairy-tale fame. In many cases expansion at any cost or even with very poor efficiency represented a gain; but in normal times these low efficiencies are, of course, not at all acceptable.

With increasing complexity of industrial conditions during readjustment, the management of chemical industry is watching much more closely every detail of plant performance. It is a fine time to get out all the old operating records and analyze them in a way that the rush of production even beyond plant capacity forbade during the several years of war-time stress. These records, which perhaps were kept in a more or less perfunctory manner, now take on increased importance; from them in many cases it will be feasible to determine the relation between operating conditions and plant efficiency. Formerly, capacity output governed; now, plant efficiency is the determining factor in success. Even though in the past the chemical staff or the engineer of tests has largely been regarded as a necessary evil set by the management to spy upon the operating force, it will be worth while to see what this chemist or engineer of tests has to show.

Perhaps some of the research-laboratory recommendations for "improvements" in process can also be tried out most successfully at a time like this. Such trials frequently result in temporary interruptions of process, small amounts of material spoilage, or temporary reduction in output. The possibility of such losses or reduced speed of operation cannot be risked during times of large demand for output. But when there is a tendency to reduce stocks and to slow up operation to permit this, the time is particularly appropriate for these trials; and if the trials result in improved efficiency, in increase of output, or in decrease of costs, there is no time when such fortunate result is more welcome.

Engineering Reports Partisan and Impartial

"IDEAL engineering reports are in effect minature court decisions. The evidence is first arranged, the arguments are presented, and finally an engineering judgment is rendered." Thus one of the well-known consulting engineers of Chicago writes in his contribution to a discussion of the function and make-up of engineering consultants' reports. The same communication goes on to discuss how material should be treated by the engineer who makes the report, giving splendid suggestions on many points. But one point is not raised in this discussion—as to the attitude of the executive or board of directors for whom the report is prepared.

Facts are often uncomfortable things and judicially minded decisions and advice sometimes are disappointing. Nevertheless, when a consultant is engaged great pains should be taken that he is given full opportunity to get the facts and render to the best of his ability an absolutely impartial report or finding. To insure this is a part of the responsibility of the executive or board for whom the report is being prepared.

An outside investigator or adviser, unless unusually tactful or of unusual fame and ability, is likely to be received in anything but a friendly way by the operating staff whose work is under scrutiny. The lot of a consultant who is to advise as between two recommendations of the staff is particularly unhappy because of these factors. However, much of the possible good from expert assistance is lost unless some executive means be found to give the whole truth as a basis for recommendations. The executive should not be satisfied with a report based upon an investigation which has been in any way hampered to prevent such judicial consideration of all important pertinent factors.

There are, of course, many occasions upon which a consultant is engaged to assist in controversial matters as between a company and the authorities, or a company and some other commercial agency with which it happens to have legal or commercial difficulties. A report prepared by a consultant or with his assistance for public use and partisan purposes is, of course, proper in such circumstances. The consultant does not expect to emphasize both sides of the question, but will limit himself to the presentation of the points favorable to his client, which he will set forth honestly and as effectively as circumstances permit. For such work the consultant becomes in effect an advocate and takes on himself all of the responsibility and privileges of the attorney advocate, except that he usually limits his effort to the technical field.

This same attitude cannot successfully be assumed in reports prepared for the assistance of executive officers. For such latter purposes a discussion of both sides of any case, setting forth the strong points for and against the decision finally reached, is most satisfactory. The executive is entitled to know the evidence on both sides. Indeed, the final recommendation of the expert is strengthened by a frank presentation of the best arguments which may be advanced against his findings, even though the final recommendation be a definite judgment. The executive who receives such report is fortunate, for he can feel sure that his adviser has taken into account both sides of the question and has not simply undertaken to present convincing arguments in support of preconceived ideas.

The Regulation Of Immigration

THE Welty immigration bill introduced in the House of Representatives May 22, 1920, receives strong support in various quarters and is likely to constitute a live issue in Congress. Very briefly stated, its object is to regulate immigration from time to time by a flexible system administered by a board to be composed of an appointed member, who shall be chairman, and the Secretaries of State, Labor, Commerce, Agriculture and Interior. Immigration is to be considered by ethnic groups and the volume of each regulated according to assimilibility and the industrial needs of the country.

It is not calling labor a "commodity" to say that the scheme is of the same order with a tariff system which seeks to encourage the importation of materials we need to import and aims to exclude materials not needed. With this fact in mind, and noting the widely divergent interests that have been represented in tariff discussions, it becomes obvious that a tremendous responsibility would have to be borne by the contemplated Immigration Board. The proponents of the bill undertake to depict the admirable results that would follow its enactment. The bill certainly aims to handle the matter of immigration in a scientific and practical manner and thus it is wholly novel by comparison with immigration legislation of the past.

The bill is naturally to be considered on the premise that there are certain objections to immigration. Those workers who object to immigration do so on the ground that they do not wish to be diluted, and do not wish the standard of employment to be reduced. The bill provides that the Immigration Board shall base its actions upon "the maintenance of American standards of living and wages," and in this respect again it becomes merely a question of whether the board functions perfectly. As to dilution, it is plainly the purpose of the proposed scheme to encourage the immigration of classes of workers we particularly need. It has been made quite plain by developments in recent years that the workers we have do not gravitate toward the various employments in the proportions that the public as a whole desires. The people in the cities insist that too many boys leave the farms. The consumers of coal insist that not enough men want to make coal mining their work, and so on and so on.

One can hardly doubt that the employment preferences of the people are not distributed in the proportion that would be best for us as a whole. If we can improve the analysis by increasing the percentages in certain lines, we should do so. If there are objections to the Welty plan on the part of groups of workers whose percentage has been tending to diminish below the proper level for the good of all, such objections should not be considered. For years there has been much preachment that we should make one occupation or another more comfortable and attractive whereby men would be moved to change their minds and take up that class of work. There has been very little success along this line. The main thing we have done is to bribe men, and that does not work well. The men are dissatisfied and seek constantly to have the bribe increased. If an ethnic group can be found that like the kind of work we do not like, it certainly would be a good plan to encourage people of that group to come and do the work. Would that not be much better than bribing an unwilling worker?

British Chemical Industry

(From Our London Correspondent)

London, Nov. 13, 1920.

With the passing of the coal strike the demand for chemicals has improved, particularly from the textile and other industries of prime importance. Nevertheless, prices remain steady, partly owing to the unsatisfactory condition of an export trade suffering from adverse exchange conditions, but mainly because the recent "shake-out" has done much to stabilize markets and to bring market prices within reasonable distance of actual manufacturing costs. The question of transport generally and the alleged unfair discrimination of the railway companies against the products of the chemical industry are receiving considerable attention and a new trade paper is to deal solely with this subject and with that of "freight exchange," which aims at the reduction of wasted "return empty" journeys. Distances being relatively small in this country, chemical manufacturers are increasingly adopting road transportation, and this tendency has been accentuated by the policy of the railway companies.

Government Delays Restrictions on Imported Dyestuffs

For some time past the daily and technical press have been innundated with articles, often apparently inspired by those chiefly affected, emphasizing the importance of maintaining the dyestuff industry on an adequate scale. and explaining *ad nauseam* its relation to chemical warfare. From the national point of view the importance of being prepared in a military sense is admitted, but the average business man has realized that compared, for instance, with the maintenance of supremacy in the cotton and piece goods trade, the value of the home dyestuffs industry *per se* is almost negligible. At the same time the government definitely committed itself, when the prospectus of the British Dyestuffs Corporation was issued, to protect the industry from German aggression, and it will be remembered that the proclamation prohibiting importation except under license was vitiated by the "Sankey judgment." A year having elapsed during which German dyes have been entering freely in ever-increasing quantities, pressure is being applied on the government to redeem its pledge by immediate legislation. It was intended to include dyestuffs in the so-called "dumping bill" which was to protect other "key" industries such as glass, etc., but as the measure is a highly contentious one as far as the other key industries are concerned, immediate and separate legislation in regard to dyestuffs seems essential if the British dyestuffs industry and the interests of its shareholders are not to be seriously jeopardized. It seems probable that the government will agree, but there is grave misgiving in regard to the matter in the cotton trade, which will naturally be the loser. It is rumored that the Board of Trade will now summon a conference representative of all interests concerned in order to enable an agreed measure to be laid before Parliament, and such a course would probably solve the difficulty.

Dyestuff Merchants Demand Export Facilities

The question of dyestuff exports and re-exports is closely bound up with this matter, because, as previously mentioned in these articles, there is a growing tendency among manufacturers, and dyestuff manufacturers are a good example, to appoint their own distributors and to eliminate the merchants wherever possible by restricting supplies to them for the export trade. Merchants are now demanding price facilities for the export trade at least equal to those of manufacturers' agents and a scheme has also been drawn up to facilitate re-export of foreign dyestuffs from bond (with reasonable customs safeguards). As regards export, it is pointed out that rather than lose the valuable foreign and particularly Eastern trade connections secured in the past, the merchants would sell German, Swiss or U.S.A. dyestuffs in foreign markets in competition with the British products, which under present conditions would probably lead to reduced exports and to unemployment in the industry. Now that the merchants have at last formed a really representative association, there is a better prospect of their interests being safeguarded and of a compromise fair to all parties being agreed upon.

Prof. Soddy Condemns Government Research Policy and Chemical Warfare Scheme

Much valuable knowledge has admittedly been accumulated during the war and since by government departments and research associations subsidized by the government. It has been agreed that discoveries made with the aid of public funds should be made available, under proper conditions, for the public advantage, but it is notorious that in many cases these results and data have been sold or transferred to the great business interests, and where publication was made, it was only on a restricted scale. This is characterized by Prof. Soddy as unfair competition. At the same time he advocates increased use of the scientific and technical faculties of the universities to supplement the work of the research associations. Writing to *Nature*, Prof. Soddy complains that the committee to be constituted for chemical warfare and research is to submit in advance to the official secrets act and protests that scientific workers should not be called upon to prostitute science in times of peace to develop a mode of warfare which has not been legalized by civilized nations.

Prospects of Electrolytic Iron

The experimental manufacture of articles by electrodeposition of pure iron has been proceeding for some time at Grenoble, France, and simultaneously by other interests in this country. The difficulties due among other things to the occlusion of hydrogen seem now to have been overcome, and important developments are foreshadowed in regard to the use of electrolytic iron in the electrical industry, the manufacture of heating coils and radiators (sometimes coated with cadmium) and the economical substitution of iron for brass and the like in one-piece containers. This industry should be of special interest to American users, as cheap power is of importance for its successful development.

Personal

Prof. C. S. Sherrington, of the University of Oxford, is to be the new president of the Royal Society.

Sir James Dobbie has retired from the post of Government Chemist.

Dr. O. Kamm, of Illinois University, has been appointed director of the chemical research department of Parke, Davis & Co., manufacturing chemists, of Hounslow and London.

Readers' Views and Comments

Engineers in Governmental Functions

To the Editor of Chemical & Metallurgical Engineering

SIR:—The war has thrown a new light upon several phases of the nation's political, social and economic life, emphasizing the need for readjustment of traditional administrative practices in public affairs in the interest of economy and conservation of resources. Long before the war there was a growing consciousness of the inadequate functioning of state and federal departments which in their nature were largely, or wholly, technical and therefore should be under the direction of trained and experienced engineers in order to obtain the most beneficial results in the interest of the public and for the money expended. Up to date the idea prevailed with the appointing power that lawyers and politicians had a prior claim upon administrative ability of whatever kind.

Of late the engineering fraternity has called attention to the inadequacy of lawyers and politicians assuming directive functions in matters for which they were not trained, with consequent wasteful use of public money, however honest the administration may otherwise be. The generally accepted reason for excluding the engineer from higher administrative functions in public service is that lawyers and politicians are by training and occupation better fitted to understand and to deal with the larger social needs of the public and to make public sentiment amenable to the requirements of governmental control. These broader, what might be called popular, qualifications are, it is claimed, not possessed by the engineer, who, however valuable as a professional man, is not trained to deal with the people and their social adjustments.

In the United States several factors have combined to give plausibility for preference of considering laymen better fitted even for technical administrative functions than professional engineers and technical men.

First, the engineer is only a comparatively recent arrival in the family of social and economic forces controlling the welfare of the public. Time is not so far distant when the surveyor was recognized as the engineer of his day and he performed the functions of an engineer in pioneer days. During all the evolutionary period there were only three socially and economically recognized professional classes—the lawyer, the doctor and the minister. What wonder then if the lawyer, as the representative of property right and law regulating the daily activities of the public, should be considered the natural incumbent of public administrative office?

Second, in a democracy the politician naturally occupies an exalted popular position in the community and is therefore considered suitable for administrative functions.

Third, the engineer represents the essentially economic side of public affairs, and the great wealth of natural resources in the United States has helped to produce wasteful, careless habits with the people, producing a natural antipathy and lack of understanding of the teachings of economy and conservation by the engineer.

The discoveries of science are enabling mankind to make generous use of the forces of nature for its own benefit, and the engineer is the learned and trained interpreter of these natural forces. If it is the lawyer's business to uphold positive law and to cultivate jurisprudence in order to maintain a state of public justice, just so is it the business of the engineer to cultivate the natural sciences in order to maintain a state of mental and physical welfare by means of scientific sewering, lighting, water supply, sanitation, bridging, road building, transportation safety appliances, etc., without which the people could not live in a state to make them receptive for the benefits of legal, medical and spiritual ministration according to the modern standard of civilization. Why then should the engineer not be considered competent at the present time and in the future, without interference by the lawyer or politician, to be at the head of the administration of those departments of public business which are engineering functions primarily and subjects of legal interpretation only secondarily?

When it comes to the application of social justice in public affairs the engineer is certainly equal to the lawyer and politician in that respect. Every well-educated engineer, of sufficient breadth of mind and experience in the management of private enterprises, should and would be competent to direct state or federal undertakings of a similar nature with greater advantage to the public interest than non-technical men who, because of their lack of technical training and experience, are frequently guided by the bureaucratic traditions of their office, with consequent waste of time and money.

If it is the purpose of social economy to make use of the mental and material resources of the country to best advantage in order to create a maximum of happiness, contentment and confidence in public institutions among the population, it is the modern engineer more than any other professional man who comes nearest to fostering and promoting this desirable purpose.

While the immediate results of the engineer's activities are of a tangible economic and commercial nature, in a larger sense these activities involve the ethical, the moral and the æsthetic life of the people because the conscientious execution of his activities by the engineer involve the ethical qualities of his sense of duty and responsibility to himself, to his client and to the community and the public at large.

On the other hand, to the degree this ethical sense of duty and responsibility toward his fellow citizens and to his country is developed among the people the more the conscientious and scientific work of the engineer will be appreciated and insisted upon for the material and moral benefit of the individual as well as of the public.

PAUL KREUTZPOINTNER.

Altoona, Pa.

Although there has been increasing recognition recently, especially in the federal departments, of the importance of technical specialists as administrative chiefs in technical work, there still is opportunity for increasing this tendency. There probably is only one need for limitation of the tendency to appointment of

technical men to administrative work for which they are particularly fitted. This is the result of the very limited number of such men who are available in comparison with the large demand for strictly technical service at the present time. An undue tendency to place technical workers in administrative function would, therefore, perhaps be an unfortunate factor, serving only to increase the shortage already acute of experienced, capable scientific and engineering investigators and consultants.

Changes in Cyanamide When Mixed With Fertilizer Materials

To the Editor of Chemical & Metallugical Engineering

SIR:—In your issue of Oct. 6 there appears a report on the program of the Fertilizer Division of the American Chemical Society as carried out at the recent Chicago meeting. The great industrial significance you attached to the paper of R. N. Harger, of the United States Department of Agriculture, has created considerable interest among fertilizer manufacturers, a viewpoint which Mr. Harger did not take in the actual paper as officially published.

The title of the paper in its official form is not "The Changes Taking Place in Cyanamide When Used in Mixed Fertilizers," but instead "The Change Taking Place in Cyanamide When Mixed With Fertilizer Materials."

Mr. Harger dealt only with laboratory mixtures of certain fertilizer materials and not with the commercial fertilizers as found on the market, as he distinctly emphasizes, and his conclusions were most carefully drawn and limited to the exact conditions surrounding his laboratory work. Since these conditions are different from those existing in the ordinary fertilizer plant, Mr. Harger in his official publication was careful to limit his conclusions to apply only to his laboratory work and not to the mixing plant.

Mr. Harger further did not carry out his work following the recommendations made by the manufacturers of cyanamide for the guidance of fertilizer mixers and as represented in the practice of the fertilizer plants, and since your report did not closely follow the details of Mr. Harger's procedure but rather implied the reverse, there has arisen in the minds of the mixers a natural question of doubt after reading your report.

I am certain you are desirous of correcting this erroneous impression created by the article in your journal and of presenting to your readers the true facts in the case as officially published by Mr. Harger. At the same time I believe you would be interested in calling the attention of your readers to the fact that the reactions described by Mr. Harger do not take place in ordinary commercial fertilizers when proceeding under recommendations for the use of cyanamide, as published by this company, and that such fertilizer mixers need not concern themselves about the presence of dicyandiamide in their mixtures, as such does not occur. Cyanamide is an extremely reactive substance, which on mixing with acid phosphate in the prescribed quantities is for a very large part converted into various ureas and in smaller part to ammonia and ammonia salts. When mixed with the ordinary ammoniated base which forms the bulk of the mixed fertilizer tonnage cyanamide reacts with the animo acids to form complex organic compounds, which so far as they have been isolated and studied are of excellent fertilizer value. Dicyandiamide cannot be produced in the presence of these ammoniated base compounds. In the ordinary acid phosphate mixture it can be produced only in extremely small quantity by a direct violation of the prescribed rules for mixing, and even then it rapidly disappears by conversion into more complex compounds of good fertilizer value.

E. J. PRANKE.
American Cyanamid Co.,
New York, N. Y.

The Paint and Varnish Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—I wish to call your attention to an article by Dr. Maximilian Toch in CHEMICAL & METALLURGICAL ENGINEERING, vol. 23, No. 10, Sept. 8, 1920, pp. 469 and 470, entitled "Putting the Paint and Varnish Industry on a Scientific Basis." The statements therein made are so at variance with the facts that it is unfair to the paint and varnish industry and to chemists long engaged in this industry to allow them to remain uncorrected.

Early in the article he states: "Prior to 1906 the most impossible and worthless mixtures paraded under the name of paint." This was doubtless as true then as it is today. He fails to state the noteworthy fact that in 1906 a considerable number of thoroughly reliable, well-equipped paint manufacturing concerns were and for many years prior thereto had been turning out large quantities of paint of a quality which has never been surpassed.

His statement, "There was at that time no literature on the subject," is entirely erroneous. He names five men who "were the only chemists in the United States who had at that time any knowledge of the chemistry of paints." In addition to these, he states, "There were perhaps three or four more like" (two names mentioned) "and others who did private work."

As a matter of fact, Dr. Toch in 1906 was listed in the membership of the American Society for Testing Materials as a paint manufacturer, and in the membership of the Society of Chemical Industry as a chemist. Within these two societies in 1906 there was a goodly number of men who had knowledge of paint chemistry.

At least twelve varnish companies were represented in the membership of the American Society for Testing Materials or the Society of Chemical Industry, or both, and of these twelve at least eight employed chemists. Other companies not so represented employed chemists. At least eighteen paint companies were represented by membership in these societies, either directly or indirectly, and of these eighteen at least ten employed chemists. Other companies not so represented employed chemists. At least fifteen great railway systems were represented by membership in these societies and all of these employed chemists, many of them engaged in work similar to that of Dr. C. B. Dudley.

The membership list also discloses (in addition to the two mentioned by Dr. Toch) at least five in New York City, one in Boston, one in Baltimore, one in Philadelphia, one in Pittsburgh and one in Chicago, engaged in private work. The membership list discloses at least one expert in paint and varnish chemistry in the federal service.

The following list is certainly not a complete roster of all the chemists who in 1906 had "any knowledge of the chemistry of paints." It is a partial list of those found in the societies mentioned, and also includes a few holding official position who may not have been

chemists. Membership in the American Society for Testing Materials is indicated by (a) and in the Society of Chemical Industry by (b):

(a) Alcott, F. L., engineer of tests, Chicago, Milwaukee & St. Paul Ry.
(b) Andrews, W. H., manager varnish works.
(a) (b) Austen, Peter T., consulting chemist.
(a) (b) Bailey, R. W., chemist, Stillwell & Gladding.
(a) (b) Baringer, F. J., chemist, Eagle White Lead Works.
(a) (b) Bjerregaard, A. P., varnish chemist, Emil Calman Co.
(a) Blanch, J. C., superintendent Blanchite Process Paint Co.
(a) (b) Browne, Arthur I., consulting and analytical chemist.
(a) Bunnell, F. O., engineer of tests, Chicago, Rock Island & Pacific Ry.
(a) (b) Burleigh, William F., technical chemist, Murphy Varnish Co.
(a) (b) Cheeseman, Frank P., paint manufacturer.
(b) Clark, Homer, chemical manufacturer, Vacuum Varnish & Chemical Co.
(a) Dabbs, Harold M., L. J. McCloskey & Co.
(a) Davidson, George M., engineer of tests, Chicago & Northwestern R.R.
(b) Dreyfus, L. A., chemist, the Muralo Co.
(a) (b) Dudley, C. B., chemist, Pennsylvania R.R.
(a) (b) Edgerly, D. W., chemist, Chilton Paint Co.
(a) (b) Forrest, C. N., chemist, New York Testing Laboratory.
(a) (b) Frank, Jerome W., chemist, Standard Varnish Works.
(a) Gibboney, James H., chief chemist, Norfolk & Western Ry.
(a) (b) Gill, A. H., assistant professor of technical analysis, Massachusetts Institute of Technology.
(b) Gladding, T. S., chemist.
(a) (b) Handy, J. O., chemist, Pittsburgh Testing Laboratory.
(a) (b) Harriman, N. F., chemist and engineer of tests, Union Pacific Ry.
(a) (b) Holton, E. C., chemist, Sherwin-Williams Co.
(a) (b) Hooker, A. H., chief chemist, Heath & Milligan Co.
(a) Hunt, Robert W., Co. Laboratory.
(a) Ingalls, F. P., chemist, John W. Masury & Sons.
(a) (b) Job, Robert, chemist, Booth, Garrett & Blair.
(a) (b) Kittredge, H. G., chemist, Kay & Ess Co.
(a) Kohr, D. A., chemist, Lowe Bros.
(a) Knapp, A. C., manager, railway department, Parrott Varnish Co.
(a) (b) Little, Arthur D., consulting chemist.
(a) Lord, Richard C., engineer of tests, Louisville & Nashville R.R.
(a) (b) Lowe, Huston, paint and varnish maker.
(a) Lucas & Co.
(a) McFarland, J. A., chemist, Missouri Pacific Ry.
(a) (b) McIlhiney, Parker C., chemist.
(a) (b) McKenna, Charles F., chemist.
(a) (b) Mahon, R. W., chemist, New York Central & Hudson River R.R.
(b) Mannhardt, Hans, chemist, Heath & Milligan Co.
(a) Marshall, William, president, Anglo-American Varnish Co.
(a) Minwax Coatings Co.
(a) Patterson Sargent Co.
(a) Patton, Ludington, secretary-treasurer Patton Paint Co.
(b) Perry, R. S., president, Harrison Bros. & Co.
(a) Phlegar, A. A., Jr., chemist, Norfolk & Western R.R.
(a) Picher Lead Co.
(a) Powers, W. A., chief chemist, Atchison, Topeka & Santa Fe R.R.
(a) Riddle, Walter V., president Sterling Varnish Co.
(a) (b) Sabin, A. H., chemist, varnish works.
(a) Scott, W. G., chemist, J. I. Case Co.
(a) (b) Smith, H. E., chemist, Lake Shore & Michigan Southern Ry.
(b) Stillwell, A. G., chemist.
(a) Suydam, Richard S., president, M. B. Suydam Paint Co.
(a) (b) Thompson, G. W., chemist, National Lead Co.
(a) (b) Toch, Maximilian, paint manufacturer, chemist.
(a) (b) Van Gundy, C. P., chief chemist, Baltimore & Ohio R.R.
(a) Von Marle, C. M., chemist, Pratt & Lambert.
(a) (b) Voorhees, S. S., engineer of tests, Treasury Department, Washington, D. C.
(b) Worstall, Robert A., chemist, Chicago Varnish Co.
(a) Wickhorst, Max H., engineer of tests, Chicago, Burlington & Quincy Ry.
(a) Wilhelm Co., The.
(a) Woods, R. W., chief chemist, Northern Pacific Ry.

Of the thirty-eight listed as members of the Society of Chemical Industry in 1906 thirteen had been in the society for ten or more years. E. C. HOLTON.

Cleveland, Ohio.

To the Editor of Chemical & Metallurgical Engineering

SIR:—With reference to Dr. Holton's letter, let me say that when I mentioned that there were only three or four more chemists in 1906 who did real work on the chemistry of paint, I should have mentioned him because undoubtedly he was one of the pioneers and entitled to a niche in the hall of fame in the chemistry of paints. His list marked "a" and "b" of members of the American Society for Testing Materials and members of the Society of Chemical Industry means very little, however, for in looking over these lists I notice the names of some who are no longer living; also many who know nothing about the chemistry of paints today. A man may be an excellent chemist in general chemistry and yet know nothing about the chemistry of our particular line. I hope Dr. Holton will realize that no discourtesy was intended by omitting his name; but I am unable to agree with his imposing list which, while it contains the names of many good chemists, lists only a few who have within the past fourteen years come sufficiently to the front to be classed as paint chemists.

New York City. MAXIMILIAN TOCH.

Important Leather Factory in Alsace Changes Hands

The announcement is made in the French press that the German firm of Adler & Oppenheimer, located at Lingolsheim, a suburb of Strasburg, and considered the largest leather factory in Europe, has been sold to a group of French and Alsatian interests for 32,000,000 fr. The group includes important financiers and business men. The new organization is constituted under the name of Les Tanneries de France, with a capital of 50,000,000 fr. divided into 500,000 shares of 100 fr. each. The plant is capable of realizing an annual turnover of from 200,000,000 to 250,000,000 fr. It is intimated that special attention will be given to exporting the products of the factory. When the Adler & Oppenheimer plant was placed under sequestration by the French considerable fear existed among French tanneries regarding the possibility of serious competition from the newly acquired factory. It is very well situated for the purpose of export to foreign countries.

Porous Plates Hard to Get

Numerous complaints having reached the chief chemist of the Bureau of Mines as to the difficulty of securing porous plates for laboratory use, the bureau is inquiring into the situation in the hope that it may be helpful in making possible a more adequate supply of these utensils.

Gas Analysis by Absorption and Titration

The Method of Gas Analysis by Absorption and Titration Has Been Simplified by the Use of a Gas Volume Compensometer for Measuring the Volume of Residual Gas, and an Alignment Chart for Calculating the Results

BY R. S. TOUR

FOR more accurate determination of certain constituents in gases—e.g., NH_3, CO_2, SO_2, H_2S—it is best to absorb the constituent in a suitable reagent, the volume of residual gas being measured, and the absorbing solution titrated. The accuracy then is that of the standard solutions, of the titration or of the measurement of the gas. Assuming the standardization and titration within the limits of accuracy desired, it becomes necessary to measure the volume of gas with the same accuracy and correct it to some known standard condition—e.g., 760 mm., 0 deg. C., dry. There then remains merely the calculation of the content of the absorbed constituent in the original gas.

The measurement of the gas and its volume correction may be greatly simplified by the use of a "compensometer," while the final calculation may be accomplished graphically with the aid of a nomograph.

GAS VOLUME COMPENSOMETER

The gas volume compensometer here described may be used to measure gas at room temperatures and pressures and to give at the same time a factor for converting this volume to standard conditions (760 mm., 0 deg. C., dry) or to read directly the corrected standard volume. The apparatus as shown in Fig. 1 is designed for an accuracy of ±0.5 per cent, although with some modifications an apparatus of much greater accuracy could be obtained.

Manipulation of the apparatus is simple. The gas to be measured is drawn through the double inlet stopcock and displaces the water in the gas flask. This can be accomplished by lowering the leveling bottle connected to the water exit of the flask, or more simply by using slight pressure on the gas to raise the water into the bottle. The gas flask is marked for some definite or convenient volumetric displacement. When water has been discharged to this point, the water exit is closed by the stopcock in that line or by pinching the rubber tube and the double inlet gas stopcock is turned to communicate with the manometer. The scale on the manometer reads either the correction factor or the corrected volume (at 760 mm., 0 deg. C., dry) of the gas within the flask.

The apparatus consists essentially of a measuring gas flask completely inclosing a compensator which connects to one leg of a manometer, the other leg of which can be opened to the gas within the measuring flask. The compensator pressure on one leg of the manometer indicates the temperature correction and if a drop of water has been inclosed within the compensator the correction includes that for water vapor pressure. The pressure of the gas in the flask acting on the other leg of the manometer tends to balance the compensator pressure and the manometer actually indicates the net correction to be applied.

Let P, p = total pressures in mm. Hg.
" T, t = temperature in deg. C. abs.
" V, v = volumes in c.c.
" A, a = water vapor pressures.

Let capitals above represent gas flask conditions and let small letters represent compensator conditions.

Let B = barometric pressure in mm. Hg.
" D = gas flask displacement in c.c.
" m = compensator manometer pressure in mm. Hg.
" K = compensator constant.
" C = conversion factor to standard conditions.

Let subscript s be used for standard conditions.

Let subscript r be used for compensator conditions at time of sealing.

Let subscript c be used for calibrating conditions.

Let subscript x be used for any operating condition.

The manometer is sealed with mercury under such compensator conditions as to give approximately no pressure differential at the average operating conditions of the apparatus. All pressure readings (m) on the manometer are to be measured from a true zero pressure point which includes a correction for capillarity.

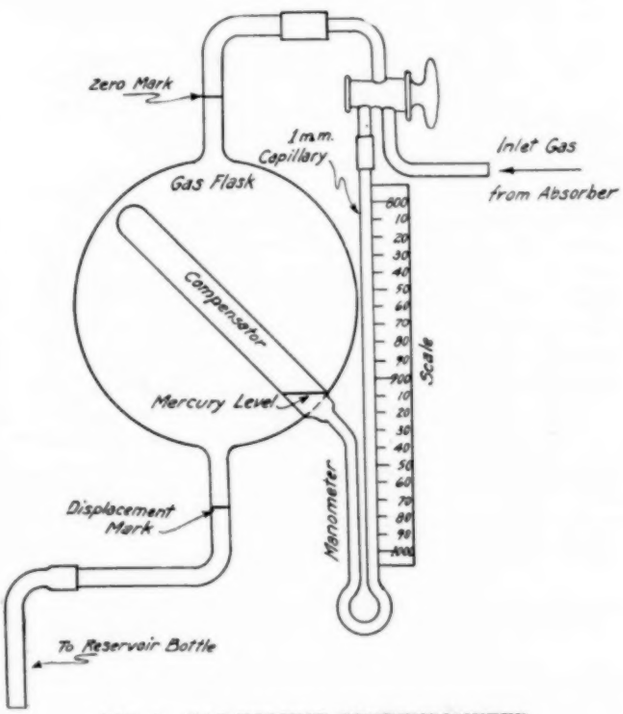


FIG. 1. GAS VOLUME COMPENSOMETER

Contribution from the Fixed Nitrogen Laboratory. Published by permission of the Chief of Ordnance.

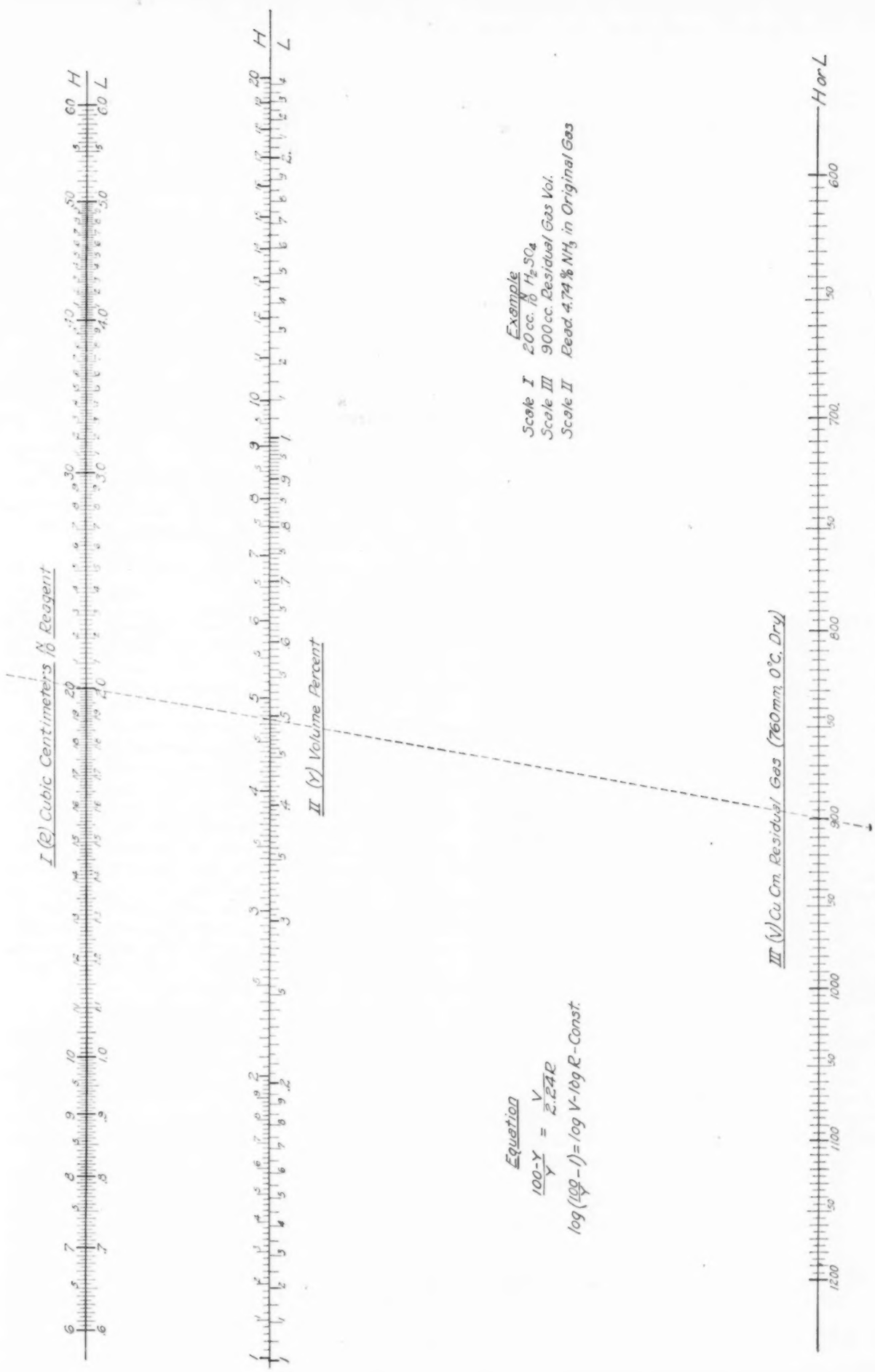

I (2) Cubic Centimeters N/10 Reagent
II (Y) Volume Percent
III (v) Cu Cm. Residual Gas (760mm, 0°C, Dry)
H or L
Example
Scale I 20 cc. N/10 H_2SO_4
Scale III 900 cc. Residual Gas Vol.
Scale II Read 4.74% NH_3 in Original Gas
Equation
$\frac{100-Y}{Y} = \frac{V}{2.24D}$
$\log\left(\frac{100}{Y}-1\right) = \log V - \log D - \text{Const.}$

FIG. 2. NOMOGRAPH FOR CALCULATING RESULTS OF GAS ANALYSIS BY ABSORPTION AND TITRATION

For calibrating the apparatus it is necessary to determine the compensator constant (K) which is based on the conditions (p_r, t_r, a_r) at which the compensator was sealed. To do this, place water of known temperature within the flask about the compensator, leaving the flask leg of the manometer open to the atmosphere. For our purposes, the compensator volume is constant and independent of the manometer reading if the manometer tube be capillary.

$$\text{Then } \frac{p_r - a_r}{t_r} = \frac{p_c - a_c}{t_c} = \frac{B_c + m_c - a_c}{t_c}$$

The temperature of calibrating determines t_c, as well as a_c, which may be read from vapor pressure tables, and p_c is equal to the barometric pressure (B_c) plus any small manometer pressure (m_c). The value of the term $\frac{p_r - a_r}{t_r}$ is thus determined and may be known as the compensator constant (K).

For graduating the manometric scale to read in terms of the conversion factor (C) to standard conditions (760 mm., 0 deg. C., dry), note that

$$T_x = t_x,\ A_x = a_x,\ P_x = p_x - m_x,\ \frac{p_x - a_x}{t_x} = K$$

Hence

$$C_x = \frac{V_s}{V_x} = \frac{T_s}{P_s - A_s} \times \frac{P_x - A_x}{T_x} = \frac{273}{760 - 4.6} \times \frac{p_x - a_x - m_x}{t_x}$$

or

$$C_x = 0.361 \left[K - \frac{m_x}{t_x} \right]$$

The term $\frac{m_x}{t_x}$ is the correction term for the variation from the average operating conditions represented in K.

In ordinary practice the value of $\frac{m_x}{t_x}$ at its maximum will be under 10 per cent of K and the value of t_x is subject to a maximum variation of ±5 per cent. Hence the average value of t_x can be assumed.

If the average value of t_x be taken at 298, or 25 deg. C., then $C_x = (0.361K) - \frac{m_x}{825}$. This represents a variation of 0.010 in the numerical value of C for each 8.25 mm. pressure on the manometric scale. The scale can then be graduated to read C directly, and for ordinary operation the range 0.800 to 1.000 covering 165 mm. is ample. If the average value of t_x be 289 (16 deg. C.), then each 8 mm. of the scale represents a variation of 0.010 in the value of C. If it is desired that the reading be directly in corrected volume, the scale is graduated according to C_xD. It is suggested that one point of the scale (e.g., $C = 0.90$) be permanently etched on the manometer tube.

Calculations

Having obtained the necessary data, there remains the calculation for the percentage content of the constituent to be determined in the original gas.

Let Q = c.c. of reagent used for titration.
" N = normality of reagent.
" R = c.c. of 0.10 normal reagent used.
" V = c.c. volume of residual gas corrected to standard conditions.
" J = valence of absorbed constituent.
" Y = per cent of absorbed constituent in original gas.

Then $22.4 \frac{NQ}{J}$ = c.c. of constituent absorbed.

$$\text{And } V + \left(22.4 \frac{NQ}{J}\right) = \frac{100}{Y}\left(22.4 \frac{NQ}{J}\right)$$

$$\text{Or } \frac{100 - Y}{Y} = \frac{VJ}{22.4NQ}$$

Taking J at unity and the normality of the standard solution at 0.100 (which solution is in general very satisfactory) then $\frac{10NQ}{J} = R$

Constitution of Nomograph

A nomograph for the graphical solution of the above equation is shown in Fig. 2. It has been of great help in routine laboratory analyses. For use a rule is laid across the three scales so that it cuts the R scale at the number of c.c. of 0.10 N reagent used and cuts the V scale at the number of c.c. residual gas measured in the compensometer. The intersection of the rule on the Y scale then reads directly the per cent of absorbed constituent in the original gas.

For plotting the nomograph with the same proportional accuracy throughout its scale, the logarithmic form of the equation was used:

$$\log \frac{100 - Y}{Y} = \log V - \log R - \text{constant}$$

The nomograph shown has an accuracy greater than ±0.5 per cent with scales and ranges as follows:

	R Scale $\frac{10NQ}{J}$ C.c. Reagent 0.10 Normal	*V Scale* C_xD C.c. Residual Vol. 760 Mm. 0 Deg. C. Dry	*Y Scale* Per Cent Composition by Volume
L Range	0.6 to 6.0	600 to 1,200	0.1 to 2.0
H Range	6 to 60	600 to 1,200	1 to 20

In this case $\frac{10NQ}{J}$ has been taken equal to R. If any other conditions than $J = 1.0$ and $N = 0.10$ apply for using the nomograph, the actual titration value Q as obtained can be corrected. For special absorption determinations where V may be very large, R may be proportioned so as to reduce V within the nomograph range.

For the determination of NH_3 in gas mixtures, for which particular analysis the compensometer and nomograph have been devised, the compensometer draws 800 to 1,000 c.c. of gas and reads the corrected volume directly on the manometer scale, the value of J is 1.0, 0.10 N acid is very satisfactory, and the nomograph reads directly the per cent volume of absorbed constituent.

Apothesin as a Local Anæsthetic

A pharmaceutical compound about which little has appeared in the literature and which has earned a place among the prominent local anæsthetics bodies because of its merits is apothesin. The cinnamic ester of gamma-diethylamino propyl alcohol is made as follows: Thirteen parts, by weight, of gamma-diethylamino propyl alcohol are dissolved in eighty parts, by weight, of benzene, and to this solution sixteen parts, by weight, of cinnamoyl chloride are gradually added. The solution deposits the hydrochloride of gamma-diethylamino propyl cinnamate in the form of white crystals, readily soluble in water, and having a melting point of 137 deg. C. This body is recrystallized from a mixture of alcohol and ether and is then ready for use. The alcohol is prepared from trimethylene glycol, a byproduct in the manufacture of soap.

Some Notes on the Effect of Nitrogen on Steel

Work Showing at Least Five Definite Layers Are Produced on the Surface of Low-Carbon Steel When It Is Exposed to Ammonia at 650 Deg. C.—Excessive Brittleness in the Outer Zones Responsible in Part for Gun Erosion

BY O. A. KNIGHT AND H. B. NORTHRUP*

IT HAS long been known that nascent nitrogen formed by the decomposition of ammonia at elevated temperatures has a deleterious effect upon a number of metals and alloys. In this connection a number of papers have been published covering the pioneer work on the subject, as well as some later ones covering the progress of further research. A few of the more important references are given below.[1]

The need of further investigation of this subject was brought to the attention of each of the authors of this paper, working severally as metallographist at the Watertown Aresnal, Watertown, Mass., and metallurgist for the Engineering Division, Ordnance Department, attached to the Bridgeport District Ordnance Office.

EXPERIMENTAL EQUIPMENT

The present investigation was carried out in order to determine the effect of ammonia on the microstructure and physical properties of steel and its possible relation to the erosion of guns, corrosion, deterioration of nitrating cylinders, etc. The effect of ammonia on a number of other alloys was also studied in an attempt to find a metal or an alloy which would not appreciably deteriorate under the influence of ammonia at elevated temperatures, and this paper consists of notes of observation which the writers have recently made and which they believe will be of value to add to the already existing data. It is with this object in mind that these notes are published.

Owing to the fact that the deterioration noticed by the writers was always accompanied by marked changes of microstructure it was believed that a study of the effect of ammonia on the microstructure would give direct evidence of its effect on the physical properties. Therefore the preliminary work consisted of a search for a metal or alloy whose structure would not be materially affected by ammonia at elevated temperatures.

In view of the fact that the deleterious effects above mentioned took place at a low red heat, and also that several industrial processes (the Haber process for producing ammonia, and others) involve the use of ammonia near this temperature, it was decided that the present experiments be conducted at a temperature of 650 deg. C.

The specimens in question were treated in a furnace of the electric resistance type. The resistor was wound upon an alundum core through which was inserted a glazed silica tube 1½ in. in diameter, inside of which the specimens were placed for the nitrogenizing treatment. Ammonia gas was generated by heating c.p. aqua ammonia in a flask, the gas being passed through a condenser, over lime, and thence through the silica tube. The temperature was accurately controlled by the use of a platinum thermocouple checked against a couple of the same type carrying a Bureau of Standards certificate. The emf. generated was measured by a Leeds & Northrup portable potentiometer.

This work has consisted in the investigation of many grades of iron, steel and other alloys, having been under way for approximately two years. Since this work was begun an article by H. E. Wheeler, entitled "Nitrogen in Steel in the Erosion of Guns," has appeared in Bulletin 160, of the A.I.M.E.,[2] in which article a great many of the metals investigated by the present writers and several others are described with reference to the effect of nitrogen on them under similar conditions. Therefore, since the appearance of this paper, the contents of which in many instances check the results of the present experiment, the major portion of the writers' work will not be reproduced. In phases of the work where the results of Wheeler do not check the observations of the writers discussion will follow later on.

An early part of the investigation consisted in heating ⅛-in. (3-mm.) diameter steel wire tensile specimens in an atmosphere of ammonia at 650 deg. C. for varying lengths of time at a pressure of about 840 mm. mercury, and the subsequent heating of some of these specimens in hydrogen. Tensile tests and microscopic examination were carried out. Pressure of about 840 mm. of mercury was maintained on the ammonia gas, as previously mentioned, by means of an open-arm manometer.

HEATING IN AMMONIA AND HYDROGEN

Nine specimens of annealed steel wire ⅛ in. in diameter, 10 in. in length (3 x 254 mm.) and containing C 0.81 per cent, Mn 0.56, Si 0.17, S and P less than 0.04 were selected for treatment. Three were pulled in the annealed, untreated condition. The six others were treated in ammonia gas for eight hours at 650 deg. C. and furnace-cooled in ammonia gas. Three of these were tested in the tensile machine, and the other three were heated in hydrogen for eight hours at 650 deg. C. and furnace-cooled. They were then tested in the tensile-testing machine. Hydrogen was generated by the action of sulphuric acid on pure zinc; it was dried before passing through the furnace by bubbling through pure sulphuric acid.

The average results of these tests are given in Table I.[3]

As will be seen from this table, the effect of heating in ammonia diminished the tensile strength and greatly reduced the elongation, while the reduction of area was rendered zero. This low value of the tensile strength

*O. A. Knight, Assistant Professor of Metallurgy, Pennsylvania State College, State College, Pa. H. B. Northrup, Chief Metallurgical Engineer, Diamond Chain & Manufacturing Co., Indianapolis, Ind.

[1]Traite de Chemie, 1834, p. 434; Savart, *Pogg. Ann.*, 1865; Despretz, *Ann. Chem. Phys.*, 1829, vol. 42, p. 122; Fremy, *Compt. rend.*, 1861, vol. 52, p. 322; *J. Chem. Soc.*, 1901, p. 285; *J. Chem. Soc.*, 1891; *Iron Age*, Feb. 17, 1916; *Revue de Metallurgie*, 1905, vol. 2, pp. 497-507; Braun, *J. Chem. Soc.*, 1905; *Bull.* A. I. M. E., May, 1919; CHEM. & MET. ENG., Mar. 3, 1920, vol. 22, p. 399; *Mining & Metallurgy*, No. 160, April, 1929.

[2]Abstracted in CHEM. & MET. ENG., vol. 23, p. 366; Sept. 1, 1920.

[3]Taken from thesis work of E. K. Mull and W. I. Potteiger, 1919.

can easily be accounted for by the extreme brittleness of the outside hard surface, which developed circular cracks extending completely around the specimen upon the application of a few thousand pounds per square inch. This cracking effect not only decreases the area of cross-section remaining but opens up a path of fracture which will continue through the interior, though

TABLE I.

Condition of Steel	Tensile Strength — Lb. per Sq.In.	Tensile Strength — Kg. per Sq.Mm.	Elongation in 2 In., per Cent	Reduction of Area, per Cent
Annealed, not treated	98,500	69.2	13.6	22.1
Annealed, heated in NH_3 for 8 hr. at 650° C.	79,500	55.9	2.0	0.0
Annealed, heated 8 hr. in NH_3 at 650° C., followed by heating 8 hr. in H at 650° C.	89,000	62.6	4.5	6.6

no doubt more ductile, portion. It will be noticed that heating in hydrogen partly restored the normal physical properties, and no doubt prolonged heating in this manner would completely restore the original physical properties. Microscopic examination showed the irregular *white layer* (so frequently discussed by other investigators and mentioned later) to be all removed by hydrogen treatment and the structure back of it partly restored to normal. Heating in hydrogen did not remove the effects of the ammonia treatment as fast as they were induced.

Search for Metal Unaffected by Ammonia

A series of experiments were next carried out with the object of finding, if possible, a metal which would stand up under the action of NH_3 at elevated temperatures. In this series no physical tests were attempted; microscopic examination alone was relied upon as a means of testing, since it has been found that the deterioration is accompanied by very distinct changes in microstructure. Therefore the object was to find a metal whose structure would be little (if any) affected by ammonia gas at 650 deg. C. and under a pressure slightly greater than atmospheric. The results of these tests may be briefly summed up as follows:

Pure tungsten does not seem to be affected by the ammonia treatment. All other pure metals tested were affected. Wrought iron and low-carbon steels are readily attacked. High-carbon steels are much more resistant than wrought iron and low-carbon steel. White cast iron is affected on the surface, but not deeply. Chromium-vanadium steels are in general the best class for resisting this action so far studied by the writers. Stellite is practically unaffected, and the alloy nichrome is also little affected; monel metal is slightly attacked.

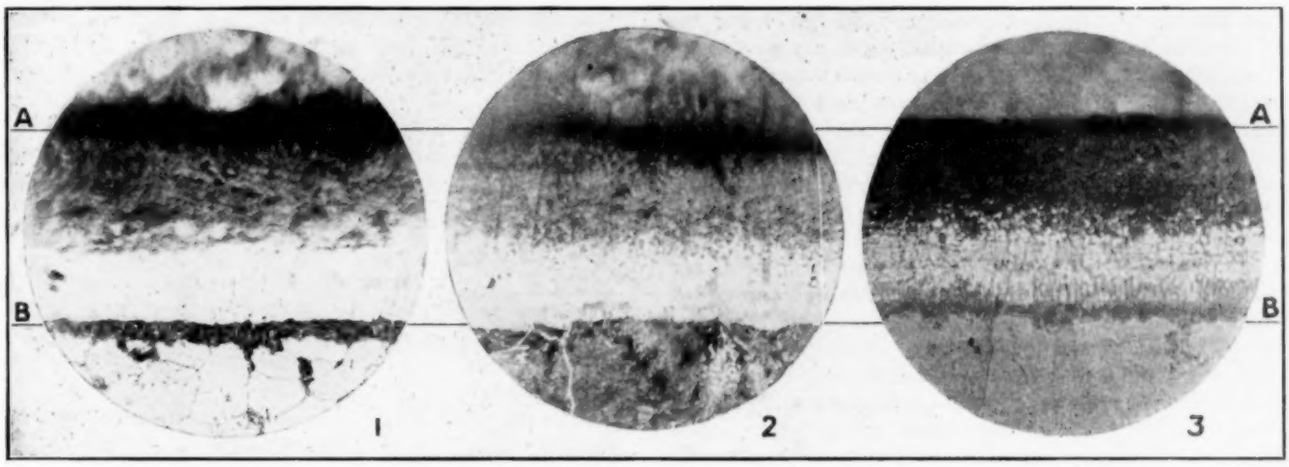
Those metals which were only slightly attacked are either impractical to apply as containers for NH_3 at elevated temperatures and pressures on account of their price or on account of undesirable physical properties, such as brittleness, hardness too great to permit machining, etc. Therefore this series of experiments seems to be of value only in a negative way.

Effect of Ammonia on Carbon Steels

It was then decided to study carefully the effect of ammonia on all the different grades of plain carbon steel, keeping all elements constant except the carbon and varying it from practically pure iron to hypereutectoid steels. This was carried out as follows: A piece of 0.07 per cent C steel, other elements normal, ½ x ½ x 1 in. (13 x 13 x 26 mm.) was casehardened by heating to and holding at a temperature of 950 deg. C. in a packing of Rodman Chemical Co.'s "Carbo S" casehardening compound for three hours and furnace-cooled. After this the specimen was removed and cut in two in the central part of its longest dimension, the surface cut being normal to the greatest axis. The surface thus exposed on the freshly-cut face varied in carbon from 0.07 per cent near the central portion to about 1 per cent on the outside (hypereutectoid distinctly), with the other elements remaining constant, unless a change took place in the percentage due to impurities in the carbonizing material.

Careful microscopic examination was made of one half of the casehardened specimen; the other was ground to a smooth surface and heated to 650 deg. C. in ammonia for twelve hours and furnace-cooled. After this treatment the specimen was removed from the furnace and cut in two on a plane normal to the surface previously exposed by cutting in two the first time. This then presented for study a surface whose carbon content ranged from 0.07 to about 1 per cent, increasing gradually, and which had been exposed alike to the action of ammonia at 650 deg. C. The specimen was then carefully mounted, as usual, in a low fusing point ductile alloy, the melting point of which was about 95 deg. C., after which it was polished for micro-examination.

Nothing unusual was noticed in the unetched condition, so the specimen was etched five seconds in 4 per cent nitric acid in absolute alcohol. It was examined along the entire edge from high-carbon to low. A very uniform layer was found all along and its average depth was 0.0073 in. (0.19 mm.), with only very slight variations from that figure. The nature of this layer was the same in the high-carbon area as in the low. The accompanying photomicrographs are arranged with the edge, or extreme outside of the steel, up and the interior portion down—i.e., below it on the page. Lines have been drawn to make clear the location of the areas under discussion. Fig. 1 shows this layer between the lines *A-A* and *B-B* taken on the low-carbon area. The structure above the line *A-A*, out of focus, is that of the alloy used for mounting, and which holds the hard brittle layer firmly in place. This layer, between lines *A-A* and *B-B*, etches differently on the outside three-fifths (approximately) than on the inner two-fifths. The outer portion is darkened and a sort of granular or finely pitted effect is revealed, while the inner two-fifths is unaffected or only slightly so by five seconds' etching. The discussion of the structure which lies deeper in—i.e., below line *B-B*—will be left till later on, but it is now desired to confine attention to this outside layer. Fig. 2 between the lines *A-A* and *B-B* shows this same layer in the region of highest carbon content. It (the normal steel) is hypereutectoid, as seen by the excess cementite around the large grains in the lower left of the picture. The thickness of this outside layer, or "case" as it will be termed in this paper, is practically the same for all the different carbon concentrations and its nature seems likewise the same. The high-carbon portion seems to etch a trifle faster, if any. Longer etching has the effect of simply intensifying the corrosive action on the outer three-fifths of the layer, making it darker, as etching progresses, until black. An entirely different effect is observed on the inner two-fifths of the case, which remains comparatively bright and structureless after etching five seconds in 4 per cent nitric acid in alcohol. Longer etching develops an interesting structure in this area. There is a definite crystalline structure and



FIGS. 1 TO 3. STRUCTURE OF NITROGENIZED LAYER ON CEMENTED STEEL. × 125 DIA. HNO_3 ETCHING
Fig. 1. Low-carbon region Fig. 2. High-carbon region Fig. 3. Layer after long etching

the crystals are of a columnar nature with their major axis normal to the outside surface. This is shown in Fig. 3 at 125 diameters after etching with 4 per cent HNO_3 for twenty-five seconds. Between the dark outside and the light columnar crystalline structure will also be seen several fine lines, having the appearance of cracks.

Further study of this portion of the case containing the columnar crystals was made at higher magnification and after longer etching.

Structure of Case Produced by Ammonia

The photomicrograph shown in Fig. 4 shows the structure of the area containing the columnar crystals as revealed by etching thirty-six seconds in 4 per cent nitric acid in alcohol and at a magnification of 400 diameters. The columnar crystals are shown distinctly as well as the fine hair cracks previously mentioned. Each one of these columnar crystals has striations crossing it in some direction and all the striations are parallel in the same crystal but extend in different directions in different crystals. The base of these crystals forms practically a straight line, and a sharp line of demarcation separates this structure from the pearlitic structure just beneath it.

The hardness of the outside layer or case is greater than any other portion. This was determined by drawing a needle point over the surface at a uniform pressure. A deep impression (microscopically) was cut in the metal by the needle point up to the case, but there very little effect was produced. The specimen was scratched after etching and the marks could be seen under the microscope to be very slight on the outside layer in comparison to the effect on the metal back of it. Rubbing the specimen gently on the rouge pad removed all traces of the scratches on the case but left deep markings on the rest of the metal. The case was much harder than the high-carbon portion of the steel, and so far as could be determined by this simple method of testing its hardness is more clearly equal that of cementite than any other constituent.

Before leaving the discussion of this outside "case" —i.e., the layer extending from the extreme outside to the base of the columnar crystals—the writers wish to emphasize more strongly its extreme brittleness. Attention is again invited to the cracks shown so vividly in the photomicrograph reproduced in Fig. 4 somewhat above and parallel to the base of the columnar crystals. The specimen was taken out of the fusible alloy and in order first to determine if these cracks were a result of sudden heating when the specimen was mounted in this alloy the specimen was heated very quickly on the edge by plunging in a bunsen flame. Examination after this treatment showed no further development of cracks. After this the edge was gently struck with the edge of a spatula at different places and again examined microscopically. The extreme outside of the case was found to have fractured along the hair cracks shown in the photomicrograph reproduced in Fig. 4. This occurred at every place the specimen was struck, and the line of fracture was always the same—i.e., near the tops (exterior ends) of the columnar crystals, consequently within the light portion of the case.

Necessity of Mounting Before Polishing

It was noticed that in all specimens not mounted a *distinct but irregular white layer* was present. This was because the exterior portion, which etches dark, has been lost during the polishing operation due to its extreme brittleness. Losses of this sort occurred after polishing early in the present investigation, until it was observed that a very constant increase in weight was obtained by giving like gas annealing to like specimens.

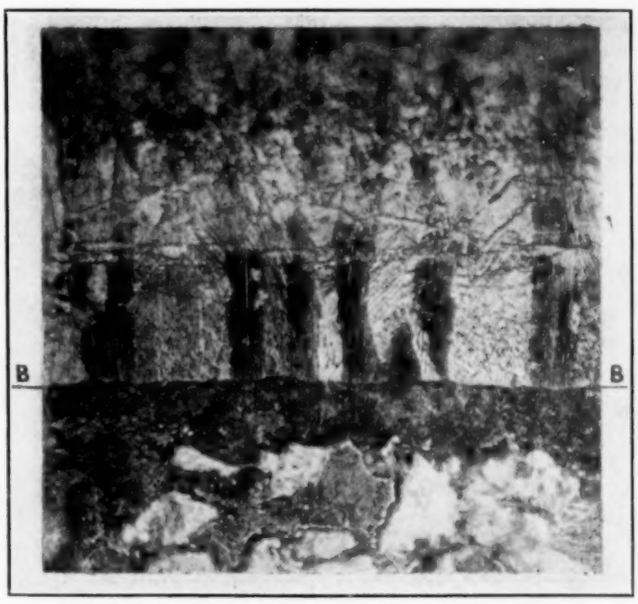


FIG. 4. COLUMNAR CRYSTALS IN NITROGENIZED LAYER. ETCHED 36 SEC. IN 4 PER CENT ALCOHOLIC NITRIC ACID. × 400

With the possibility that spalling could be giving the erratic misroscopic results, mounting was resorted to. When this was done examination showed very regular depths of case when like specimens were treated in the same way. This is somewhat contrary to Wheeler's views, which he expresses on page 30 of his paper (*Mining and Metallurgy*, No. 160, April, 1920) as follows:

"The object of treating a number of alloy steels twenty hours in NH_3 at 650 deg. C. and in some cases at 750 deg. C. was to observe the depth of the case formed and gather an idea of the effect of the added element in retarding or accelerating this reaction. The method is far from quantitative. For instance, two steels, each of 0.40 per cent carbon and 1 per cent chromium, one of 0.20 per cent vanadium and the other of 0.25 per cent vanadium, would not give in half a dozen experiments consistent results as regards the depth of penetration. Such fine distinctions are beyond the scope of this method."

While Mr. Wheeler does not mention whether or not his specimens were mounted before polishing, nor does he mention the extreme brittleness of the outer surface exposed to NH_3, the present writers fear, in case his specimens were not mounted, the spalling of the edge led him to conclusions which are not quite correct.

Let us examine a few photomicrographs, in this connection, prepared by the writers of specimens mounted and not mounted. The photomicrograph shown in Fig. 5 shows the type of case produced by treating a plain low-carbon steel in NH_3 twelve hours, followed by furnace-cooling and polishing with great care in the ordinary way—i.e., not mounted. The case is seen to be very irregular. Other views at the same magnification and nearly the same location on the same specimen give white cases from one-third to one-fifth the thickness. Another steel of eutectoid composition showed such irregular and jagged edges as are revealed in Fig. 6.

As soon as such gross irregularities as this appeared as a result of microscopic examination and in view of what would be expected from the gain in weight observed on many treated specimens it was decided at once that mounting was necessary to make an accurate study of this case.

Table II gives the weight before and after treatment in NH_3, together with the actual and percentage increase in weight, of isx specimens of steel wire ¼ in. in diameter and cut approximately to the same length.

One can see at a glance that a greater degree of regularity exists in weight gain than would be expected from such an irregular surface. Consequently the specimens from this time on were mounted in the low melting point alloy previously mentioned. This resulted in uniform cases, as was expected. The photomicrograph

TABLE II. GAIN IN WEIGHT OF ¼-IN. WIRE AFTER AMMONIA ANNEALING

Specimen No.	Weight Before NH_3 Treatment	Weight After NH_3 Treatment	Gain in Weight	Per Cent Gain
1	3.5822	3.6104	0.0282	0.79
2	3.9745	4.0045	0.0300	0.75
3	4.1864	4.2166	0.0302	0.72
4	4.3250	4.3550	0.0300	0.70
5	3.9836	4.0128	0.0292	0.73
6	3.9621	3.9909	0.0288	0.73

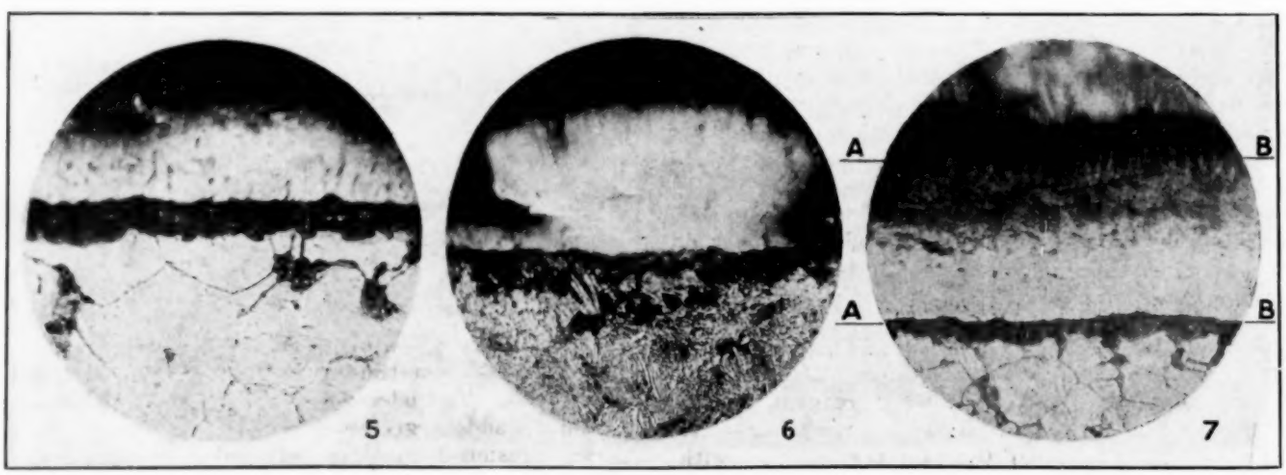
reproduced in Fig. 8 shows the same steel as shown in Fig. 5 (at 125 diameters instead of 200, because all the case could not be conveniently shown at high power).

This degree of uniformity was found on all specimens mounted, though in some instances the case would be cracked, but held in place by the low melting point alloy.

Inspection of all of Mr. Wheeler's photomicrographs shown in his excellent paper noted above, taken on the edge of specimens to show the depth of case, shows that none were mounted. On account of this the present writers are very skeptical regarding the accuracy of some of the conclusions to which he has been led.

Pearlitic Layer Under Brittle Surface

Let us turn now to the rest of the microstructure produced by the ammonia treatment. Referring again to Fig. 1, taken in the region of low-carbon content, a thin dark layer, appearing to be high in carbon, is seen at the inside of and immediately next to the white layer—that is, at the base of the columnar crystals. Examination of this layer at higher magnification reveals a pearlitic structure, as shown clearly in Fig. 4, at 400 diameters. This layer was scrutinized microscopically from the low- to the high-carbon region, and it had the same appearance all along. In the high-carbon area it was in the form of pearlite grains, each grain surrounded by a thin film of excess cementite, seemingly the same as the normal structure, so that nitrogenization in this region produced the so-called "case" previously described, beneath which there was no evidence of a change in microstructure.



FIGS. 5 TO 7. VARIATION IN SURFACE LAYERS CAUSED BY POLISHING METHODS, HNO_3 ETCHING

Fig. 5. Low-carbon steel, polished without mounting. × 200.

Fig. 6. Eutectoid steel, polished without mounting. × 200.

Fig. 7. Same steel as Fig. 5, polished after mounting. × 125.

FIG. 8. SO-CALLED NITROGEN NEEDLES BENEATH THE SURFACE. × 125. HNO_3 ETCHING

In the low-carbon region something entirely different is observed. First, a thin layer (approximately 0.0007 in. or 0.017 mm. in thickness) pearlitic in appearance is found just beneath the columnar crystals; then comes a layer whose thickness equals about the width of two rows of ferrite grains, in which the structure of these two rows of ferrite grains appears normal. Just beneath this is found a layer of considerable thickness (not measured, but of greater thickness than all the other layers combined), in which the ferrite grains are found to contain a great number of the (so called by other investigators) nitrogen needles. This is shown in Fig. 8, at 125 diameters. Below this the normal structure of the low-carbon steel prevailed.

Restating conditions, we may say that in the high-carbon region there is a very brittle "case," which on its outer three-fifths etches dark and on its inner two-fifths light at first but depicts columnar crystals on further etching, beneath which case no change of structure was observed, whereas in the low-carbon area the same type and depth of "case" was observed, beneath which was a thin layer pearlitic in structure or pearlitic containing some sorbite, beneath which in turn was a layer about two grains in width which appeared unaffected; then follows the area containing nitrogen needles, and then the true normal structure. It is clear from this that in so far as microscopic examination of a sample etched with HNO_3 is able to show the nitrogen liberated by decomposing ammonia under the conditions stated has a far greater penetrating power on low-carbon than on high-carbon steel. It is recognized that nitrogen needles may be effectively masked by pearlite normally existing in high-carbon steels.

An explanation as to the reasons for the formation and existence of the different types of structure here shown will be left until more data are accumulated.

Specimens were etched with Stead's reagent, iodine, and boiling sodium picrate. Stead's reagent blackened the outside three-fifths of the case very quickly with a heavy copper deposit, while the nitrogen needles were light in a dark background. The columnar crystallization was vividly shown and the thin layer immediately beneath it was darkened. Boiling sodium picrate developed a most interesting structure, but the writers wish to withhold a discussion of these results until further study can be made, when a slightly higher melting point alloy will be used for mounting the specimens so they will not become loosened during the etching. Iodine gave no results that were not better shown by some other reagent.

Corrosion and Casehardening

A series of experiments were carried out to determine if the case produced by ammonia was of any value in resisting corrosion. Several specimens of 0.80 carbon steel were subjected to the action of ammonia at 650 deg. C. for twelve hours, after which they were given accelerated corrosion tests. As compared to the same steel not treated in ammonia the specimens thus treated were much more resistant to corrosion *provided* the specimen, after nitrogenization, was not subjected to stresses which would develop cracks in the brittle case. Specimens were tested which had the case intentionally cracked by light stresses, and these gave very poor corrosion tests. Since the case fractures so easily it is hardly possible that it can be useful in this way. As to casehardening, the writers firmly believe that cyanogen compounds used for casehardening give more brittle cases than compounds which do not contain cyanogen and that this brittleness is due to nitrogen. This was suggested earlier by Le Chatelier, and Braune reports needles similar to "nitrogen needles" in *Revue de Metallurgie*, 1905, vol. 2, p. 497, in his report on baths containing cyanide and ferrocyanide of potassium.[1]

Nitrogen (or Chemical) Theory of the Erosion of Guns

Early in 1917, when the first of the present writers was studying the erosion of two 10-in. rifles at the Watertown Arsenal, Watertown, Mass., a report of which will be found on page 245 of "Tests of Metals and Other Materials at the Watertown Arsenal During the Fiscal Year Ended June 30, 1917," he was led to believe that nitrogen liberated by the chemical changes taking place during the burning of the powder reacted with the metal lining of the gun and formed compounds which play a considerable part in the erosion of the bore, and it was at that time that he first offered this theory to his immediate superiors at that place. While this supposition was rejected at the time, the work of the past three years has done more to prove than disprove this point. In view of the extreme brittleness and fragility of the surface of steel after exposing it to the action of nascent nitrogen at elevated temperatures it has been and is the firm belief of the writer that this action goes on within the bore of guns and that the fragile substance formed, be it iron nitride or not, is, owing to its nature, readily swept away by the physical forces so well known. It therefore is believed that when attempts are made to reduce erosion to a minimum this point should not be overlooked and if at all possible a steel should be specified which has as high a resistance to the action of nascent nitrogen as is possible and at the same time meet the necessary physical requirements. The later work of Wheeler, previously referred to, adds a great deal to the strength of this theory. Erosion is therefore believed to be caused by chemical as well as physical and thermal changes.

[1] See also Brophy and Leiter on "Cyanide Hardening Due to Nitrogen," CHEM. & MET. ENG., vol. 23, p. 568, Sept. 29, 1920.

Determination of Nitrogen Oxides in Processess for Nitrogen Fixation

By Guy B. Taylor

MANY investigators in the field of electrical discharges through gases have need for an accurate method of analyzing gases for nitric oxide. In many cases these investigators are not trained chemists, but may be physicists or electrical experts. In casting about for a method suited to their purpose, they naturally seize upon the obvious one of absorbing the nitrogen oxides in an excess of standard sodium hydroxide solution and titrating the excess alkali with standard acid after absorption. This method in the hands of an inexperienced analyst will unquestionably yield inaccurate results. The purpose of this note is to describe a simpler method, one not so likely to lead to errors as the alkaline absorption method.

Ehrlich and Russ[1] showed that nitrogen peroxide is quantitatively converted to nitric acid by hydrogen peroxide solutions. This reaction serves as the basis of the proposed method which is carried out as follows:

The gas is sampled by allowing it to fill an evacuated glass bottle provided with a glass stopcock. For arc-furnace gases a two-liter bottle is convenient. The volume of the bottle must be known as well as the previous degree of evacuation. If an excess of oxygen is not normally present in the gas to be sampled, oxygen gas must be added to the sample to convert nitric oxide to nitrogen peroxide. After filling the bottle to atmospheric or some other exactly known pressure and ascertaining the filling temperature, introduce 25 to 50 c.c. of 1.5 per cent hydrogen peroxide solution and shake until the reddish color of NO_2 disappears. Let stand at least five minutes and shake again. Then titrate the acid solution in the bottle with N/10 sodium hydroxide, using methyl orange as the indicator.

Practically all hydrogen peroxide solutions are acid in reaction. To prepare the reagent for the analysis, dilute the commercial 3 per cent peroxide with an equal volume of water and neutralize with N/10 sodium hydroxide, using methyl orange indicator.

To calculate to per cent nitric oxide, let

a = c.c. N/10 alkali used.

v = volume of bottle in c.c.

b = barometer in millimeters of mercury, corrected.

p = pressure in bottle before sampling, millimeters of mercury.

t = temperature of gas sample, deg. C.

Then

$$\frac{2.24\,a}{v\left(\frac{b-p}{760}\right)\left(\frac{273}{273+t}\right)} \times 100 = \text{per cent NO}$$

This formula holds for low concentrations of nitric oxide, say up to 3 per cent NO, where the volume change due to formation of nitrogen peroxide may be neglected. To convert per cent NO to grams HNO_3 per cubic meter of gas at standard temperature and pressure (0 deg. C., 760 mm.) multiply by 28.

In many cases the temperature of the gas at the point of sampling is considerably higher than room temperature, in which case it is not practicable to determine the temperature of the gas in the bottle at the moment of closing the stopcock. In such cases proceed as follows: First, introduce the peroxide reagent with a rubber tipped pipette so that no air enters. After absorbing the nitrogen oxides, allow a measured volume of water to enter the bottle until the residual gas is at atmospheric pressure. Titrate as described above. In addition to the previous notation, let

w = vapor pressure of water at t deg. C.

v^1 = volume of peroxide plus water introduced into the bottle. Then

$$\frac{2.24\,a}{\left[(v-v^1)\left(\frac{b-p-w}{760}\right)\left(\frac{273}{273+t}\right)\right]+2.24\,a} \times 100$$

gives the percentage of NO.

The advantage of the above-described method lies mainly in the fact that only one standard solution is required and there is no trouble from bleaching of indicators by nitrous acid. Most indicators suitable for titrating in the presence of nitrites are sensitive to CO_2. This means that in the alkaline absorption method the standard sodium hydroxide solution must be prepared free from carbonates and carefully protected from the air after its preparation. Another serious source of error that an inexperienced investigator is likely to encounter is a mathematical one. The tendency is to use five or six or even ten times as much alkali for absorption as is neutralized by the gas, with the result that burette errors and errors in the factors of solutions are magnified. There is no possible advantage in any excess alkali above that required to keep the absorbing solution barely alkaline. Such excesses of alkali may lead to serious misintepretations of results, when, as is often the case, conclusions are based on a difference of 2 or 3 c.c. of the standards.

Experimental Station,
Wilmington, Del.

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[1] *Monatsh.*, vol. 32 (1911), p. 917.

France the Richest European Country in Iron Ore

It may not be generally known that France is the richest country in iron ore in Europe, and that the United States is the only country in a position to challenge her for the leading position of the world. With the restoration of Alsace-Lorraine, it is estimated that the French output will be 45,000,000 tons of iron ore a year, of which 17,000,000 tons will be exportable.

The successful organization of the export trade has now been brought about by the Comptoir Sidérurgique de France, which has absorbed the Comptoir des Poultrelles and the Comptoir d'Exportation des Produits Sidérurgiques. The large forges or steel works, by means of a combination known as the Committee of Forges, are securing increasing interests in iron mines, waterpower, coke ovens and mechanical engineering shops. In order to obtain the best results in foreign trade there has been created an industrial unity comprising the mine, the forge, the workshop and the bank. The opportunity has been taken by important French firms to secure in the markets of the world the position formerly occupied by organizations of a semi-industrial and semi-trading character, such as the Metall-Gesellschaft.

Engineering undertakings of all kinds have for many years been chief factors in French expansion abroad—particularly in Asia Minor, Russia and South America. A great many South American ports are under the management of French enterprises. The Maison Fougerolle Frères and the Société Générale d'Entreprises have between them executed contracts of a total value of 950,000,000 fr. and are now making elaborate plans for the extension of their foreign business.

Need of Professional Solidarity Among Chemists*

A Succinct Review of the Status of the Chemists as Related to the General Welfare of Their Profession, and as to Their Duty to the Community and the Nation

By H. C. PARMELEE

THE United States needs a consciousness of chemistry as a factor in its national welfare, and the only man who can create that consciousness is the chemist. The war laid the foundation for this achievement. It remains for the chemist to build the superstructure, not only in the public interest but also for the advantage of professional solidarity. The immediate aim thus seems to be twofold, but the ultimate accomplishment is single in its purpose—the reaction of chemical thinking on the life and activities of the people.

It is safe to say that the part played by the chemist in the World War brought him into public prominence as did none of his previous scientific and technologic achievements. The reason is that his services touched directly the great mass of the people. He came out of the seclusion of his laboratory and stood forth as a fellow citizen, specially trained to meet a need that was insistent, sudden and unexpected. His performance commanded the respect of soldier and civilian alike. He "arrived" with almost unprecedented efficiency and became a factor of prime importance. His work stood out as eminently practical and was shorn of much of the mystery that had previously surrounded him in the public mind. In fact the public suddenly became conscious of the chemist, just as it was conscious of the surgeon as a necessary adjunct to the army.

But the public had long been conscious of the surgeon in its civil life as a necessary adjunct to peaceful pursuits. Why had it not so recognized the chemist? It was not because he had not played an important part in the daily life of the nation, for he had. For years he had been controlling important industries—the manufacture of steel, the production of foodstuffs, the winning of gold and silver from their ores, the manufacture of medicines, the purification of municipal water supplies, the making of paper and ink, the application of fertilizers, the production of dyes, the preparation of salt, soap, starch and sugar. For years he had been thus close to the public interest and yet had failed to gain the recognition that was accorded to other professionals.

A Needed Public Consciousness Relating to Chemists Wrought by the War

The nature and importance of the chemist's work were comparatively unknown to the great mass of the people, for whom his queer apparatus and strange solutions and smelly laboratory were shrouded in mystery.

The war wrought a sudden change. The chemist became a marked man; and while he was drafted, it was not into the infantry, but into the laboratory and plant for the production of munitions. Much of his work was the same as it had been in times of peace—the production of steel, food, medicine, metals, fertilizers, soap. The principal difference lay in the channels to which the products of his ability were diverted. He gained more publicity and greater recognition; there was no longer quite so much mystery about the nature of his services.

It is safe to say that before the war the average citizen, on discovering that his neighbor was a chemist, would say, "Oh, yes," in a hazy sort of way, and then either change the subject or inquire, "Well, just what do you do?" And if the reply indicated, for example, that the chemist worked in the laboratory of a railroad company or a packing house, the mystery would only be deepened. But let the same man casually learn that his neighbor was a lawyer or a doctor, and immediately he would understand that man's place in society and his relation to the community; and it would matter not whether the lawyer or doctor were employed at a smelting works or a sugar factory, the average citizen would understand the nature and value of his services. And this because there was a public consciousness relating to doctors and lawyers which had not yet developed regarding chemists and chemistry.

Professional Solidarity Fostered by Self-Consciousness

Granting that the chemist is no longer an unknown quantity in the public mind and that the importance of his part in the general scheme of things is recognized and admitted if not fully understood, the next step is the creation of professional solidarity among chemists by fostering a modest self-consciousness of their relation to society and their duty to the community and the nation. The chemist may not again retire to the obscurity of his laboratory and plant. He has certain abilities and ways of thinking that can be turned to good account in public affairs. He possesses knowledge of incalculable and practical value and benefit to the public, and the public is entitled to it. And more: if the chemist is to be satisfied with the conduct of business and government, he must apply thereto his qualities of precision, accuracy, efficiency, integrity and all other mental products of his education and training, or else refrain from criticism of those who lack his knowledge and point of view. Like the engineer, his preparation for professional work "makes him exact, precise, honest, efficient, unshackled by tradition, aggressive in attacking a problem, sound in analysis and judgment, and fearless in execution."[1] These qualities are quite as useful for citizenship and government as for scientific pursuits, and those who possess them are obligated

*Excerpt of an address delivered before the New York alumni of Alpha Chi Sigma, and published in *The Hexagon*, September, 1920.

[1] "The Engineer and His Thinking," Chem. & Met. Eng., Aug. 18, 1920, p. 265.

to exercise them in the public interest. And so it is now incumbent on the chemist to develop a consciousness of his duties and obligations to society. That self-consciousness will draw the members of the profession together and ultimately give them a sense of power that comes with unity. Solidarity, community of interest, will not be achieved if the chemist attempts to remain in "splendid isolation." In fact, neither he nor his profession will flourish, nor will he gain public recognition as a member of a great profession if he remains in isolated independence. The chemist must change his way of thinking of himself as an individual and look upon himself as a member of an important profession.

What Professional Solidarity Can Accomplish

We may take a lesson in ways and means to accomplish this from another profession of marked solidarity. Lawyers are organized in bar associations everywhere, and through these associations the voice of the profession becomes articulate. The public recognizes a pronouncement by a bar association on any subject of public welfare as a professional expression of opinion from a group of men qualified to pass technical judgment. Influence is thus exerted which would be impossible for any individual to put forth. The effect is cumulative: a sense of professional solidarity leads the bar association to speak with authority; the public is impressed by the weight of organized opinion and learns to respect it. This gives the association a new sense of power and responsibility and encourages it to assume leadership which the community, in turn, finally accepts as a matter of course. The relations become mutually advantageous. But the point to be observed is that the entire development had its inception in the consciousness of a group or class of men, due to similar training and habits of thought. So it must be with the chemist. To borrow a phrase from our labor friends, he must acquire "class consciousness," or, as it is better phrased, professional solidarity.

The Chemist Must Impress the Public With His Own Worth

It has often been humorously remarked that the lawyer has gained his position of professional prominence in the public mind by simply assuming it—by talking himself into it. There is quite as much truth as humor in the statement. Oratory is part of his stock in trade and he uses it for advertising purposes. And advertising may not be neglected, especially when promoting a new venture. If the chemist is to rise to a position of professional prominence and recognition he must, to use a modern commercial phrase, "sell himself" to the public. Publicity begins at home. If the chemist does not impress the public with his own worth, nobody will do it for him, at least not to the extent of creating that chemical consciousness which we want to see in the public and that sense of solidarity which we want to create among the chemists themselves. Advertising is essential. A man in the dark may know where he is, but nobody else does. He needs an illuminated sign. Likewise the chemist is a worthy citizen, but if he carefully refrains from collective action and expression nobody will be cognizant of his importance or gain the benefit of his knowledge. Lawyers assume leadership in government, acquire places on the directorates of large corporations, and otherwise gain distinction in public and private life. They and their opinions find favor with financiers and industrial leaders. The same road to distinction is open to the chemist if he first gains that sense of professional fellowship and community of interest, and then impresses the public with his ability for leadership. There is no inherent reason why he cannot be recognized by bankers and business men as a professional necessity equally with the lawyer.

An Appropriate Machinery for the Realization of the Chemists' Professional Solidarity

There remains, then, the consideration of the machinery for accomplishing this professional solidarity. Some form of organization or association immediately suggests itself, but a new addition to our already long list of societies does not make a favorable appeal. True, the engineers, who have been confronted with this same problem of crystallizing a professional sense out of the prominence and importance which the engineer gained in the war, have deemed it advisable to organize new societies; but it is doubtful if this is necessary for the chemists. Their technical society already is functioning in this respect to a certain degree, and that activity can be increased. In the meantime Alpha Chi Sigma offers a fertile field for the cultivation of the ideas herein expressed. Composed of men who presumably have a lively sense of fellowship as well as exceptional technical ability in chemistry, it affords a culture medium for the propagation of the thoughts that are beginning to find expression. Through its publication, *The Hexagon*, it should be possible to disseminate that particular kind of advertising which will demonstrate the importance of the chemist as a citizen and his relation to society, thereby fostering the professional sense and gaining public recognition. The fraternity should have some definite activity, for without it there can be no binding force to hold it together and make it useful. In helping to create this professional solidarity it would be doing the very thing that would make the fraternity flourish as a graduate or alumni organization—and that is where most alumni organizations fail, in a lack of common interest. If the alumni of Alpha Chi Sigma were to get the spirit of the new professional life that is now opening before chemists, they would leaven the whole body of technologists in a short time.

Restriction of Rubber Production Agreed Upon

At the beginning of 1920 the price of rubber in London was 2s. 11d. (71c. at normal exchange) a pound, from which it fell to 1s. 5¼d. (35c.)—a figure very little above the average producing costs. Owing to the absence of American and British demand, stocks in London steadily increased, and finally, a month or so ago, the Rubber Growers' Association (London) recommended that production should be reduced by 25 per cent of the estimated normal monthly output, either by resting one-quarter of the tapping area or, preferably, by alternate-day tapping over one-half of the tapping area. If 70 per cent of the producers agreed, this scheme was to be put into operation Nov. 1.

The suggested scheme of restricted output has now received the necessary support, and the plan went into operation on Nov. 1, 1920. Under the agreement, the 25 per cent curtailment of production will operate until December, 1921. It is pointed out that while the output of rubber has increased five times since 1912, the price has fallen to less than one-fifth of the quotations then ruling.

Putting the Responsibility on the Student

BY JOSEPH W. RICHARDS

. . . care being taken to convey instruction in such a shape as not to make it compulsory on them to learn; because no trace of slavery ought to mix with the studies of the freeborn man.—PLATO.

AMERICAN institutions of higher learning are conducted entirely too much on the kindergarten plan and far too little on the principle of letting students work of their own volition. In the primary, secondary and grammar schools the hapless student is the object of a rigid system of "must," which leaves him no alternative but to work his hardest at the task imposed. In the high school things are much the same; lessons are assigned in a textbook, recitations are the principal exercise in the class room, and a rigid system of scoring absences insures that no student can be absent more than a specified number of times without being disciplined.

Our colleges, technical schools and universities continue this mechanical forcing of the student to his work. Every day has its appointed tasks, every hour is full of responsible duties, every precaution is taken that the student do at least the minimum amount of work before being passed for graduation. In fact, his teachers largely take upon themselves the burden of making him work; if a goodly proportion of the class does not attain the pitiful minimum of 60 per cent, the teacher's conscience begins to hurt him—he has not made them work hard enough.

Under these conditions, which prevail quite generally, what opportunity has the student to learn his own responsibility to keep himself at work? With no option but to attend and grind, how can he feel any right sense of the great opportunities which are his? He is forced to do what he ought to be happy to do of his own volition, and his better nature rebels at the compulsion. But his rebellious spirit finds no chance to realize its ideals; he is in the grip of the machine, he must do the work assigned and forced upon him, and he does it often with a discontented attitude, because he is made to do it.

What is the remedy? It is undoubtedly to put university students on their own responsibility, so that they can practice keeping themselves at their work. Do not *make* them do anything; let them make themselves do everything. You cannot teach a boy to use a knife without giving him one to use; he will probably cut himself in learning how, but give it to him you must. It is the same with the student's responsibility to bear his own burdens and to keep himself up to his work; the compulsion to work must be removed before the student can learn to take care of himself. Keep up the compulsion always, and you are robbing him of the chance to learn how to order and guide his own powers and his destiny; put the responsibility on him, and you are giving him the chance to learn to bear it.

The conclusion just stated may sound revolutionary and visionary to those so set in the old ways that they cannot see over the fences hedging in their narrow paths; but it works! Try it. Take no absences, hear no set recitations, stop treating university students like schoolboys who have to be made to work, and treat them like men who know what they are at college for and mean to get it.

Then eliminate the weaklings and the neglectful by occasional examinations, fairly given and carefully read and assessed. If a student shows that he has not been doing what he should and what he knew was expected from him, give him his medicine, drop him out after perhaps one warning; he has eliminated himself. This leaves in college the earnest and capable and the workers. They are all to whom the institution owes any obligation. Their work will progress better and more profitably by reason of the elimination of the unfit.

It is no proper part of the duty of a university teacher to make a student work. Lead the horse to water, but you cannot make him drink; it is folly to try. Tell the student of his great opportunities, spread the feast before him, but do not try to force him to eat. By this policy it is possible to eliminate from our American colleges and universities the indifferent, the unwilling, the "deadwood" of our classes, and to confine our further efforts to the inquisitive, the willing, the seekers after knowledge, who will work as hard as anyone could wish, without any compulsion.

This is the teachers' as well as the students' paradise—a university where no compulsion exists and students bear themselves the responsibility of working, led by the helpful advice and sympathetic counsel of their co-workers—the teachers.

Lehigh University,
Bethlehem, Pa.

The Theory of Gas-Scrubbing Towers With Internal Packing

BY W. B. VANARSDEL

IN A RECENT article[1] on this subject by F. G. Donnan and Irvine Masson they first give a brief review of the rather scanty literature on the theory of gas scrubbing and then proceed to give attention to the results of Adeney and Becker,[2] which show that in the case of gases which obey Henry's solubility law, the rate of solution at any moment is proportional to the unsaturation of the liquid at that moment. The following is a brief summary of their calculations.

If m = the concentration of absorbable component in the gas phase and n = the corresponding concentration in the liquid, the rate of solution is proportional to $km - n$, where $k = \frac{n}{m}$ at equilibrium; that is, k is the Henry coefficient. The rate of solution depends also on a coefficient k_2, which the authors call the *dissolution coefficient*, and they remark: "Under strictly specified conditions this coefficient will be a constant quantity, but in general its value will increase with the degree of relative motion of gas and liquid and the degree of turbulence in both. The part played by the very thin 'stagnating layer' in hindering the exchange of heat energy or matter between different phases is well known to be a decisive factor in the design of heat interchangers and recuperators, furnaces, dissolvers, extractors, etc., and the thickness of this layer is diminished by increase of relative motion of the phases and by rupture of this layer due to the splashing of drops. We may term k_2 a *dynamical coefficient*."

In developing the theory of gas absorption in countercurrent towers on this basis Donnan and Masson con-

[1] *J. Soc. Chem. Ind.*, vol. 39, p. 236T (1920).
[2] *Proc. Roy. Dublin Soc.*, 1918-19, vol. 15 (N. S.), pp. 385, 609.

sider only the simplest case, by making the following assumptions:

1. Temperature kept uniform and constant throughout the tower.
2. The volume percentage of the absorbable gas constituent is supposed fairly small, so that volume changes due to its removal may be neglected as a first approximation.
3. The solubility of the main gas constituent is neglected.
4. The vapor pressure of the scrubbing liquid is supposed to be such that volume changes due to saturation of the gas with this vapor may be neglected as a first approximation.
5. The flow of both gas and liquid is supposed to be uniformly distributed over every cross-section of the packing.
6. The wetted area of the sides of the tower is neglected in comparison with the wetted area of the packing.
7. The absorption is a simple "physical" absorption—i.e., one not complicated by relatively slow chemical reactions in either gas or liquid.

The following symbols are used, calling the absorbable constituent of the gas X:

M_1 = grams of X per cu.m. of entering gas.
M_2 = grams of X per cu.m. of issuing gas.
m = grams of X per cu.m. of gas at level x in the tower.
N_1 = grams of X per cu.m. of entering liquid.
N_2 = grams of X per cu.m. of issuing liquid.
n = grams of X per cu.m. liquid at level x in the tower.
x = distance measured vertically downward from top of packing.
h = total height of packing.
V_g = flow of gas in cu.m. per minute.
V_l = flow of liquid in cu.m. per minute.
S = area of cross-section of tower (supposed uniform).
k = Henry coefficient as defined above.
k_1 = "coefficient of packing," area of interface between gas and liquid, in sq.m. per cu.m. of packing.
$f = \frac{V_g}{V_l}$ = "flow ratio."
$r = \frac{M_2}{M_1}$ = ratio of absorption.
k_2 = dissolution coefficient as defined above.

The authors point out that the coefficient of packing, k_1, must also be considered as a dynamical coefficient, since its value does not depend alone on the average wetted surface of the packing units, but may be due in large part to drops of liquid, in the form of drips and splash. It probably rises as the volume of liquid increases, but reaches a maximum and perhaps thereafter decreases when the flow becomes large enough to form small continuous streams.

Considering the element of volume between the heights $x - dx$ and x in the tower, the following fundamental equations may be formed:

$$k_1 k_2 S(km - n)\,dx = V_g\,dm \qquad (1)$$

$$n = fm - (fM_2 - N_1) \qquad (2)$$

When these equations are combined, the resulting differential equation integrated and the limiting conditions substituted, either of two forms results:

$$\text{Log}_e \frac{(k-f)m + (fM_2 - N_1)}{kM_2 - N_1} = \frac{k_1 k_2 S(k-f)}{V_g}\,x \qquad (3)$$

$$\text{Log}_e \frac{(k-f)M_1 + (fM_2 - N_1)}{kM_2 - N_1} = \frac{k_1 k_2 S(k-f)}{V_g}\,h \qquad (4)$$

If $N_1 = 0$, as will often be the case,

$$\text{Log}_e \frac{k - f(1-r)}{kr} = \frac{k_1 k_2 S(k-f)}{V_g}\,h \qquad (5)$$

The authors also write the simplified forms which result from assuming that M_2 is zero or negligible, or that the liquid issuing from the base of the tower is in equilibrium with the incoming gas.

In their conclusion it is shown that these equations give in a quantitative manner the way in which a high absorption efficiency depends on:

1. High interfacial area between gas and liquid.
2. High relative motion of gas and liquid (within limits).
3. High degree of turbulent motion in one or both phases.
4. Sufficient rate of flooding to secure the maximum drip effect.

Simplification by Use of Heat Interchanger Formulæ

These calculations are of great interest to all engineers who have anything to do with gas absorption on a large scale. For this reason it seems to the writer that attention might well be drawn to some simple consequences of the theory. The labor of calculation can be greatly diminished and the results become more significant when it is realized that the gas-scrubbing tower can be rigorously compared to a heat interchanger. The weight, W, of absorbable constituent which passes from one phase to the other may be determined from:

$$W = Ak_2 C_m Z \qquad (6)$$

where A is the area of interface between liquid and gas, k_2 a constant for the particular tower and manner of liquid and gas distribution, analogous to the constant of "conductivity" used in heat-exchange calculations, C_m a "mean concentration difference" analogous to the "mean temperature difference," and Z the elapsed time. Now on the basis of the expression derived by the authors for the variation in concentration with the level in the tower (counter-current flow) it is easy to deduce a value of C_m which will make equation 6 true. This value is as follows:

$$C_m = \frac{(kM_1 - N_2) - (kM_2 - N_1)}{\log_e \frac{kM_1 - N_2}{kM_2 - N_1}} \qquad (7)$$

where M_1 is the concentration of the entering gas, M_2 that of the issuing gas, N_1 that of the entering liquid, N_2 that of the issuing liquid and k the "Henry constant," according to which, at saturation, $kM = N$. In case the absorption does not follow Henry's law, but an empirical relation between M and N is known, it is possible again to define C_m in concentration terms only, but its form is almost certain to be much more complicated.

The perfect analogy of C_m to the "logarithmic mean temperature difference" familiar in the heat calculations is obvious. The tower-constant, k_2, thus receives a more definite and suggestive meaning because of the familiarity of the heat-interchanger problem.

Brown Co. Research Dept.
Berlin, N. H.

Determination of Atmospheric Impurities—I

A Description of the Nature of Atmospheric Impurities, With Special Reference to Salt Lake City, Utah, Conditions—Methods and Apparatus Used for Their Determination—Results Obtained—Physical Character of the Solid Atmospheric Impurities

By OSBORN MONNETT

EXACT knowledge of the nature and amount of atmospheric impurities is of considerable value in carrying out plans for smoke abatement. Ringelmann chart readings show the density of smoke as it leaves the stack and serve to show the relative importance of different classes of smokes and the amount of smoke sent into the atmosphere. They do not, however, show how much of this smoke actually stays in the city. Local topographical and weather conditions affect the nuisance profoundly. Thus Salt Lake City, whose gross coal consumption and smoke production are low compared with many other cities, has as aggravated a smoke nuisance as any city in the country. This is due to its location in a region of low wind velocity, in a valley almost surrounded by mountains. Another city of equal size and equal coal consumption but situated in a region of higher wind velocity might show identical Ringelmann chart figures and yet have very little smoke nuisance. It is evident, then, that figures showing the concentration of soot and other impurities in the atmosphere of the city are needed.

Such data show the sources of pollution in order of importance and tell the engineer in a very definite way what he must contend with. They also serve as a standard of reference for future years to determine with accuracy the progress made by smoke abatement measures. Conditions existing in cities today give rise to pollution of the atmosphere with soot and fine ash from burning of coal, with dust from traffic and industrial operations, and with small amounts of poisonous gases from industrial plants and coal fires. These all add to the "smoke" nuisance and contribute their share to making city air more or less detrimental to the health of the inhabitants and injurious to property.

Nature of Atmospheric Pollution

Pullution of city air is of several kinds:

1. Soot from burning of coal in industrial operations, large heating plants and domestic stoves and furnaces. This soot is the largest source of harm and annoyance. It is a mixture of varying proportions of carbon, tarry products of coal distillation, sulphur acids and ash. Taken in with the air we breathe, it lodges in the throat and nasal passages, and the finer particles get into the lungs. The presence of tar and sulphur acids makes it an active irritant and predisposes the breather to throat trouble and pneumonia. This soot soils and damages our clothing, curtains and woodwork and injures vegetation. Smoke from high-pressure plants tends to be high in ash and contains little tarry matter. Smoke from low-pressure plants and domestic stoves and furnaces is higher in tar acids and oily products of combustion and is more detrimental to health, property and vegetation.

2. Gases from burning of coal, from manufacture of industrial products and from decay of organic matter. Among these are sulphur dioxide, sulphuric acid, hydrogen sulphide, ammonia, chlorine, nitrogen acids and carbon dioxide. Of these only sulphur dioxide formed from the burning of coal and sulphuric acid formed from the sulphur dioxide by action of air and water vapor are usually present in more than negligible quantities. These are both poisonous and corrosive gases. In the West considerable litigation has taken place between farmers and smelters as a result of damage done to crops and live stock by sulphur dioxide from the roasting of ores. The relation of sulphur dioxide to the Salt Lake problem will be discussed fully in a later paragraph.

3. Dust of non-fuel origin. This includes considerable quantities of fine dust from industrial and building operations, paving dust from traffic, pollen, spores, decayed organic matter and soil. Such dust is as a rule less harmful to health and property. In Chicago it is estimated that 41 per cent of the solids in the atmosphere are of non-fuel origin.

Nature of Atmospheric Pollution in Salt Lake City

There is a very marked seasonal variation in the character and amount of atmospheric impurities in Salt Lake City. In the growing season from April through October the impurities are principally dust of non-fuel origin. With the beginning of the heating season the amount of coal smoke begins to increase until in December and January the city is often hidden in a pall of fog and smoke so dense that it is impossible to distinguish objects at 100-yd. distance. This smoke cloud is seldom pure soot, but is usually mixed with water vapor. The humidity in winter is high and smoke particles act as nuclei for the condensation of water vapor. This makes fogs of more frequent occurrence than if the atmosphere contained no foreign particles. Such fogs are dissipated with difficulty by the sun and may exist without evaporation for a considerable time even though the humidity of the atmosphere is considerably below saturation.

In the winter, when the smoke nuisance is at its height, the atmosphere is remarkably free from dust of non-fuel origin, but contains relatively large amounts of soot and ash from coal fires. Such material, due to its color and fine state of division, is a much greater nuisance, weight for weight, than the coarser and heavier industrial and other dust. A given weight of such soot will soil as large an area of white collar or lace curtain as one hundred times its weight of coarser

EDITOR'S NOTE: This is a chapter of the smoke-abatement report made by the Bureau of Mines in June, 1920, on its work in Salt Lake City, where it had the co-operation of the city and State University authorities. Published by permission of the Director of the Bureau of Mines.

dust. Hence although, as shown later, the actual weight of solid matter in the atmosphere is not extremely high, the actual nuisance in terms of soiling and damaging fabrics and architecture is very bad.

Methods Used to Determine Atmospheric Impurities

Three general methods have been used in the past for estimating the quantity and kind of solid matter in the atmosphere.

1. Filtration methods, in which a known amount of air is filtered through a paper or cotton wool filter. The weight of solid matter entrained by the filter may be expressed as weight per unit volume of air or the relative blackness of the filter may be used as a measure of the amount of solid matter present. Filters are examined microscopically to determine the character of solids and their relative amounts.

2. Counting methods, in which a known volume of air is blown against a prepared glass slide which is subsequently examined microscopically both as to number and character of particles. Results are expressed as to number of particles per cubic centimeter.

3. Settling methods, in which vessels of known dimensions are set up in places away from direct contamination by nearby stacks and the soot allowed to collect for a month or more. The deposit is subsequently weighed and examined chemically and microscopically. Results are expressed in tons of deposit per square mile per annum.

All of these methods give valuable information and none of them tells the whole story in itself. The filtration method, in which the actual weight of solid material per cubic foot is obtained, gives an exact figure which may be compared with results in other cities. On the other hand, it tells little of the character of the

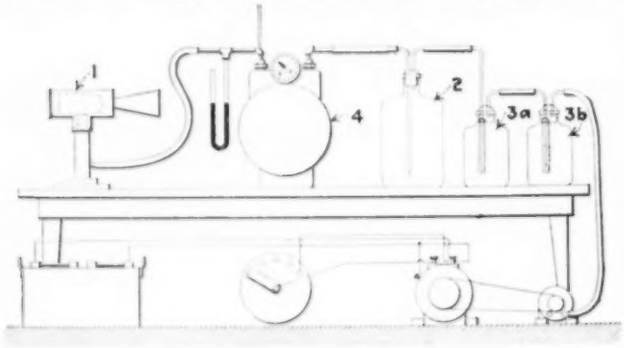


FIG. 1. APPARATUS FOR ATMOSPHERIC ANALYSIS

solid matter, and the presence of large particles of high specific gravity gives a high figure which may not indicate the actual degree of smoke nuisance. Several hours are needed for securing a weighable amount of solid matter. The procedure gives only an average result.

The method in which the number of particles in a given volume of air are counted allows instantaneous samples to be taken and tells something of the character, size and shape of the particles.

The soot fall method makes possible the collection of sufficient material for analysis and gives a basis for calculation of the amount of combustible matter discharged per annum. However, the amount of matter of other than fuel origin which finds its way into the jars is considerable and it is a difficult task to separate the constituents.

It seems best, then, to use if possible all these methods in order to definitely classify the solid material in the air as to nature and amount. Such results are of great value in expressing in a fairly exact way the extent of the smoke nuisance and serve as a standard by which the nuisance may be compared in successive years and with that prevailing in other cities.

For estimating gaseous impurities standard analytical procedure may be employed and accurate results obtained. The amounts of the various impurities are expressed in milligrams gas per cubic meter of air or in parts gas by volume per million parts air.

Description of Apparatus and Methods Employed

The apparatus employed in determining the amount of solid matter and other impurities in a given volume of air was essentially the same as used by the Chicago Smoke Abatement Committee.[1]

The analytical train as shown in Fig. 1 consists of:

1. Filtration apparatus.
2. Bottle for carbon dioxide determination.
3a. Absorbing solution of sodium hydroxide for determination of nitrous acid, chlorine and sulphur acids.
3b. Absorbing solution of hydrochloric acid for determination of ammonia.

The apparatus used for determining sulphur dioxide in the atmosphere will be described later.

A gas meter was placed between the filtration apparatus and the rest of the train to record the amount of air aspirated through the filter and train. A 6-volt motor and storage battery operating a rotary pump served to draw air through the train. About 10 cu.m. of air was drawn through the apparatus during the test, which lasted about six hours.

Filtration Apparatus

The apparatus as shown in the figure was arranged to hold a paper filtration thimble 43 mm. in diameter by 123 mm. long and to keep the thimble against the wind during the test in order to have duplicable conditions throughout. The collecting tube of the apparatus swings on a ball bearing and is sealed airtight with a mercury seal.

Considerable trouble was experienced in accurately weighing the paper thimbles. They were found to be extremely hygroscopic, changing several tenths of a gram in weight from day to day owing to changing humidity. In the procedure finally used the thimbles were dried in a constant temperature oven at 50 deg. C. for one week. Air dried over sulphuric acid was passed constantly through the oven. The thimbles were then allowed to cool in a dessicator over sulphuric acid and weighed in an aluminum container having a tight fitting screw top. This procedure was repeated from day to day until the weight was constant to 1 mg. Better accuracy than this could not be obtained. After use the thimble was again dried to constant weight.

Results were calculated in milligrams solids per cubic meter of air.

Determination of CO_2

The Pettenkofer method was employed.

Solutions Used. 1. Oxalic acid of strength such that 1 c.c. = 0.25 c.c. CO_2 at 0 deg. C. and 760 mm. pressure.

[1]Report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals, W. F. M. Goss, chief engineer. Rand, McNally & Co., Chicago, 1915, pp. 40-48.

Pure recrystallized oxalic acid ($H_2C_2O_4 2H_2O$) to the amount of 1.407 g. was dissolved in one liter of water and kept in a brown bottle. The strength of this solution is checked frequently by titration with N/20 sodium hydroxide.

2. Barium hydroxide of strength such that 50 c.c. baryta solution neutralizes 30 to 40 c.c. oxalic acid solution. This solution is prepared from a saturated solution of barium hydroxide by dilution with water. It was kept in a bottle having a soda lime tube and 50 c.c. overflow pipette.

3. Phenolphthalein solution. One gram of pure phenolphthalein is dissolved in 100 c.c. of 86 per cent alcohol. Two drops of this solution are used in the titration.

Procedure.—A wide-mouthed bottle having a volume of about four liters was used. This was placed in series with the analytical train and air aspirated through it for half an hour. The bottle was then removed from the train, corked with a rubber stopper in the center of which was a hole plugged with a small rubber stopper. The small stopper was then removed, 50 c.c. of standard baryta solution was run in from a pipette and the stopper replaced. The bottle was then shaken at intervals for twenty minutes so that the liquid wetted the sides completely. The excess baryta was then titrated with standard oxalic acid. A blank was also run on 50 c.c. of the baryta solution. Knowing the strength of the oxalic solution in terms of CO_2, the volume of the bottle, and the temperature and pressure, it was possible to calculate the carbon dioxide present. This was expressed in parts per million of air.

Determination of Nitrous Acid, Chlorine and Sulphur Acids

Absorbing Solution.—One pound of sodium hydroxide is dissolved in eight liters of water and 400 c.c. of this solution is placed in the absorbing bottle.

Analytical Method for Nitrous Acid.—The solutions used are:

1. Sulphanilic acid. Sulphanilic acid to the amount of 4 g. is dissolved in 500 c.c. of acetic acid, specific gravity 1.04.

2. Alpha-naphthylamine. Alpha-naphthylamine to the amount of 2.5 g. is dissolved in 500 c.c. of acetic acid, specific gravity 1.04.

3. Standard nitrite solutions. (*a*) $AgNO_2$ to the amount of 0.328 g. is dissolved in hot distilled water in a liter flask. Pure NaCl to the amount of 0.3 g. is added and when cold the solution is made up to a liter with distilled water, thoroughly shaken and the precipitate allowed to settle. (*b*) 100 c.c. of solution *a* is diluted to one liter. (*c*) 10 c.c. of solution *b* is diluted to one liter. 1 c.c. of solution *c* = 0.001 mg. HNO_2.

The procedure is as follows: Dilute to 50 c.c. 5 to 25 c.c. of the NaOH solution from absorption bottle, 15 c.c. of acetic acid, 2 c.c. each of No. 1 and No. 2. This is compared in a calorimeter against a standard solution made by adding 10 c.c. of solution *c* to 30 c.c. acetic acid, 150 c.c. of unused NaOH solution, 5 c.c. of No. 1 and 5 c.c. No. 2. A blank must be run on the NaOH solution.

Analytical Method for Chlorine.—The per cent of chlorine in Salt Lake air was too small to permit of estimation by the usual gravimetric or volumetric methods. Recourse was had to nephelometric estimation of the density of the precipitate of silver chloride.

The solutions used are:

1. Standard NaCl solution. Dissolve 0.165 g. pure fused NaCl in one liter of water. 1 c.c. = 0.1 mg. chlorine.

2. Standard NaCl solution. Dilute 10 c.c. of solution No. 1 to one liter in a graduated flask. 1 c.c. = 0.001 mg. chlorine.

3. Approximately N/100 $AgNO_2$.

4. Approximately N/10 HNO_2.

The procedure is: To 30 c.c. of NaOH solution from the absorption bottle are added 10 c.c. of N/10 HNO_2 and 10 c.c. N/100 $AgNO_2$. The solution is heated for thirty minutes at 50 deg. C.

A standard is prepared by adding to 110 c.c. of unused NaOH solution 10 c.c. NaCl solution No. 2, 40 c.c. N/10 HNO_2, 40 c.c. N/100 $AgNO_2$, and heating for thirty minutes at 50 deg. C.

These are compared in a nephelometer of the Kober type. A blank must always be run on the NaOH solution.

Analytical Method for Sulphur Acids.—Just neutralize with conc. HCl 200 c.c. of NaOH solution from the absorption bottle, add 5 c.c. HCl in excess, add a little bromine water and boil the solution until the color is dispelled; add 25 c.c. of 10 per cent $BaCl_2$ solution and heat the solution on the water bath for one hour. The solution is then filtered and the paper ignited and weighed.

Determination of Ammonia

Absorbing Solution.—Dilute 20 c.c. of concentrated HCl to one liter. Eight liters of this solution is made up at a time.

Analytical Solutions.—There are two of these:

1. Standard NH_4Cl solution. Place 3.141 g. dry NH_4Cl in a liter flask and make up to one liter with distilled water. Dilute 10 c.c. of this solution to one liter with NH_3-free water, 1 c.c. = 0.01 mg. NH_3.

2. Nessler's solution. Dissolve 50 g. KI in smallest quantity of cold water. Add a saturated solution of $HgCl_2$ until a faint show of excess is indicated. Add 400 c.c. of 50 per cent KOH solution. Filter through asbestos on a Büchner funnel and make up to one liter.

The procedure is: Place 50 c.c. of the HCl solution in a Kjeldahl flask and add 20 c.c. 1 : 1 KOH and 80 c.c. NH_3-free water. Distill 100 c.c. into a Nessler tube and add 2 c.c. Nessler's solution. This is compared in the calorimeter with a standard of suitable strength made from the NH_4Cl solution.

Method of Determining Sulphur Dioxide

A very sensitive method for determining small amounts of sulphur dioxide in air has been developed by A. E. Wells[2] in connection with the work of the Selby Commission. This method was used to determine the amount of sulphur dioxide in the air of Salt Lake during December, 1919, and January and March, 1920.

A description of the method and apparatus used, essentially that described by Wells, is given herewith.

Briefly, the method consists in taking samples of the air to be tested by means of evacuated 24-liter bottles containing starch solution faintly colored with iodine. Comparison of this color with that of a blank and addition of iodine solution of known strength until colors

[2]Holmes, J. A., Franklin, Edward C., and Gould, Ralph A., Report of the Selby Smelter Commission, Bull. U. S. Bureau of Mines, No. 98, 1915, p. 43.

match enables quantitative determination of SO_2 in amounts as low as 0.1 part per million.

The solutions required are:

1. N/100 iodine solution. Place 1.27 g. of c.p. resublimed iodine and 5.0 g. of potassium iodide in a graduated flask and make up to one liter with distilled water.

2. N/100 sodium thiosulphate solution. Place 2.48 g.

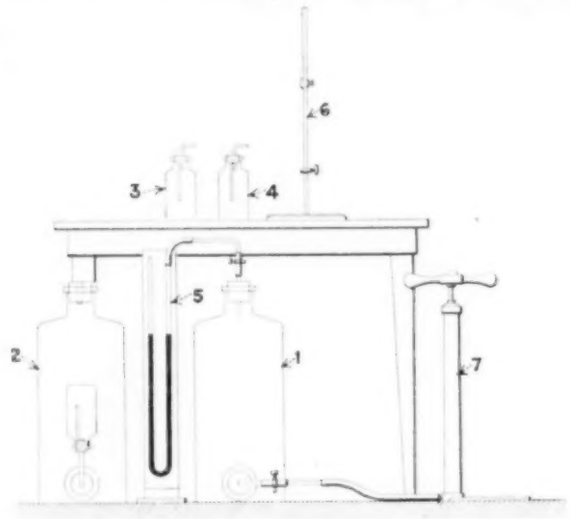


FIG. 2. APPARATUS FOR DETERMINATION OF SULPHUR DIOXIDE

of pure $Na_2S_2O_3.5H_2O$ in a graduated flask and make up to one liter with distilled water.

3. N/500 iodine solution. Run 50 c.c. of the N/100 iodine solution from a pipette into a 250-c.c. graduated flask and make up to the mark with distilled water. The solution is titrated against the N/100 thiosulphate solution; 5 c.c. N/500 iodine solution should equal 1 c.c. of the thiosulphate solution and 1 c.c. of the N/500 iodine solution is equivalent to 0.0224 c.c. SO_2 gas at 0 deg. C. and 760 mm. pressure.

Starch solution. Add 2 g. potassium iodide to 400 c.c. distilled water and heat to boiling. One-half gram

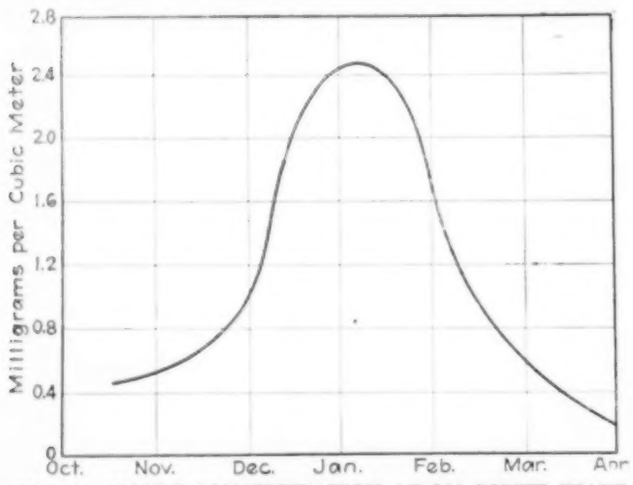


FIG. 3. SMOKE CONCENTRATION AT 344 SOUTH STATE STREET, SALT LAKE CITY, 1919-1920

soluble starch is then added and when this has dissolved the solution is allowed to cool. This solution must be made fresh every day.

Fig. 2 shows the apparatus employed. Bottles 1 and 2 are of 24-liter capacity. Bottle 1 is used in taking the samples. It is fitted with two single bore rubber stoppers containing glass tubes which may be closed by rubber tube and pinch cock as shown. Bottle 2 serves merely as a check and is fitted with single bore stoppers closed with glass plugs.

The titration bottles 3 and 4 are of clear white glass and about 400 c.c. capacity. They are fitted with two-hole rubber stoppers containing a right angle tube extending just through the stopper and a straight tube cut off below the top of the stopper and extending to a point just above the solution. In transferring the solution to the large bottle the finger is placed over the hole in the stopper and the bottle inverted. This transfers the solution without contamination from the air.

The manometer shown (5) is used in determining the pressure in the bottles. The manometer is so calibrated that by noting the temperature and evacuating the bottle to the mark corresponding to this temperature on the manometer scale the amount of SO_2 present may be read off directly in parts per million by multiplying by 2 the number of c.c. of N/500 iodine used. The manometer is calibrated by substituting in the formula[a]

$$M = \frac{273 + t}{0.000813V}$$

Where M = manometer reading in inches, t = temperature in degrees Centigrade and V is the volume of

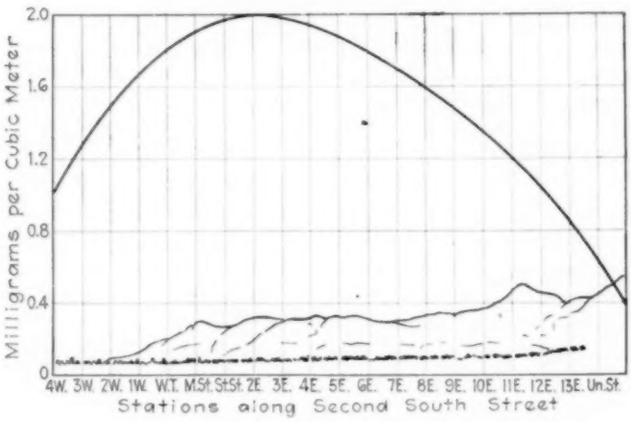


FIG. 4. AVERAGE SMOKE CONCENTRATION ALONG SECOND SOUTH STREET DURING DECEMBER, 1919, AND JANUARY, 1920

aspirator bottle in c.c. minus 200 c.c. (the space taken by the starch solution). Values of M corresponding to different temperatures are marked on the manometer scale and labeled with the corresponding temperature. A hand vacuum pump (7) is used in evacuating the bottle.

Procedure.—Place 400 c.c. of starch solution in one of the titration bottles and add iodine solution until the solution has assumed a definite lavender tint. The solution is then divided equally between the two bottles, the plugs removed from the tubulature stoppers in the aspirators, the right angle tubes of the titration bottles inserted in the stoppers and the solution transferred to the aspirator bottles. The titration bottles are then detached, the glass plugs reinserted, and the aspirators shaken for one minute. The solutions are then returned to the titration bottles for comparison.

In case a discharge of color in either bottle is noted, the solutions are mixed, a small amount of iodine solu-

[a] The formula assumes a constant pressure 25.4 in., an error of about 1.5 per cent.

tion is added to restore the original tint and the operation is repeated until the color of starch solution is not altered by the treatment. The bottles are then SO_2-free.

The solutions are then put back in the aspirators and the check bottle is closed with glass plugs. The manometer is connected to the upper stopper of the other aspirator and the vacuum pump to the lower. The bottle is evacuated to the point corresponding to the temperature and the pinch cocks are then closed and manometer and pump disconnected.

The top pinch cock is then opened and the air allowed to flow in, the bottle being shaken vigorously as the sample is taken and for one minute after. The blank

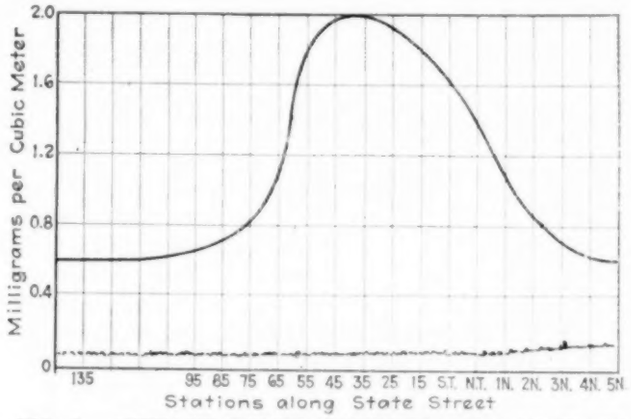


FIG. 5. AVERAGE SMOKE CONCENTRATION ON STATE STREET DURING DECEMBER, 1919, AND JANUARY, 1920

bottle is shaken for one minute. Solutions are then transferred to the titration bottles and the color of the determination restored to the same tint as that of the control by addition of N/500 iodine solution from the burette. The number of c.c. iodine multiplied by 2 gives the quantity of SO_2 in parts per million.

In this way 0.1 part per million of SO_2 can be detected. Accuracy is about 10 per cent for concentrations between 0.2 and 1 part per million.

Result of Atmospheric Analyses

Solid Matter.—The solid matter in Salt Lake City atmosphere varied during the time of observation (November-April) from less than 0.1 mg. per cu.m. to a maximum of 2.5 mg. per cu.m. From microscopic examination the solid matter so obtained is very largely of fuel origin and is in a very finely divided condition. There is both a seasonal and locational variation in the amount of solid matter present in the atmosphere. The highest concentrations were noted during the months of December and January and in the business district. Lower concentrations were observed during the other months of the year and in the outlying residential districts.

In Fig. 3 concentrations at 344 South State St. have been plotted throughout the time of observation in order to show the seasonal variation. It will be seen that the concentration rises from 0.5 mg. liter early in November to 2.5 mg. liter in January. It falls off to less than 0.1 mg. liter in the latter part of April. These figures are necessarily averaged over the entire day, since six or seven hours was needed to collect a weighable amount of solid material. The months of December and January are the times of minimum temperature and wind velocity, conditions favorable to the production of a large amount of smoke and a slow dissipation of the smoke formed.

Fig. 4 shows the average concentration along Second South St. during December and January. The concentration reaches a maximum in the business district, falling off gradually to a low point at the University.

Fig. 5 shows an east-west concentration variation on State St. during December and January. Again it is evident that the high concentration occurs in the business district.

These curves indicate in a general way the average concentrations. Individual days may vary to a large extent from the curves due to peculiar weather conditions. Sufficient data have been collected to verify in a very striking manner data from Ringelmann chart observations that the largest smoke production is in the center of the city within the zone of highest concentration as shown in Fig. 6.

Carbon dioxide determinations showed a variation from 270 to 430 parts per million, or an average throughout the year of 335 parts per million. No regular variation of the amount of carbon dioxide with the month or location in city could be discovered.

The quantity of carbon dioxide present averages but 35 parts per million higher than that present in the

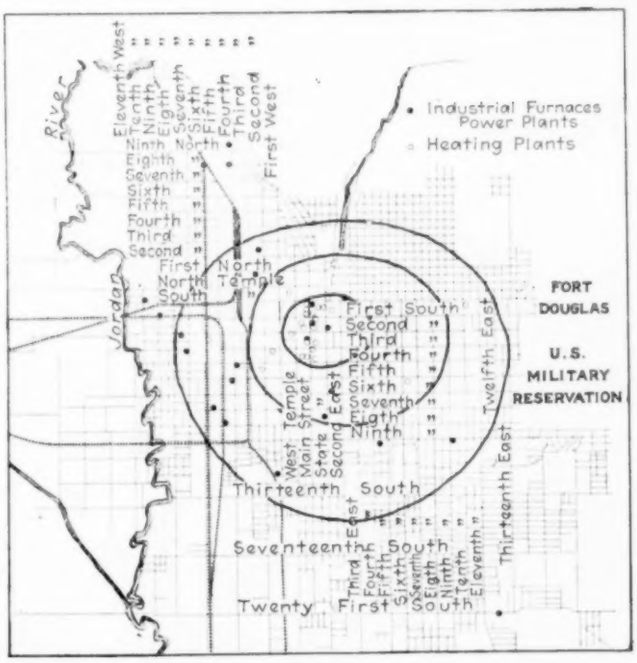


FIG. 6. MAP OF SALT LAKE CITY, SHOWING THE LOCATION OF INDUSTRIAL FURNACES, POWER AND HEATING PLANTS AND ZONES OF SMOKE CONCENTRATION

pure country air. Carbon dioxide is a negligible factor in the pollution of Salt Lake City atmosphere.

Nitrous Acid.—Analyses showed a variation in the nitrous acid content of the air of from 0.009 to 0.0322 mg. per cu.m. The amount of nitrites present is higher on smoky days than on clear days.

Chlorine is present in very minute amounts, possibly carried as spray from the Great Salt Lake. Only a few determinations were made. These varied from 0.002 to 0.004 mg. per cu.m.

Sulphur acids are present in amounts less than 0.1 mg. per cu.m.

Ammonia varies from 0.001 to 0.08 mg. per cu.m.

None of these impurities is present in harmful amounts.

(Part II will be published in a subsequent issue.)

Corrosion Prevention in Petroleum Refining Vapor Systems

By Ralph R. Mathews and Philip A. Crosby

In a previous article[1] we showed that when petroleum which contained brine, with magnesium chloride as one of its constituents, was distilled in pipe stills, hydrochloric acid was evolved by hydrolysis, and in consequence serious corrosion took place in the fractionating system and in the condensers. Michael Freund[2] has also shown that such a reaction takes place, his observations being made on a Russian crude oil, and others have noticed corrosion when such oils were refined. As it is desirable to prevent, if possible, the rapid corrosion caused by the hydrochloric acid produced, several different methods have been investigated, and this paper covers some of the results obtained.

At the suggestion of President van der Gracht, of the Roxana Petroleum Corp., anhydrous ammonia was first tried as a neutralizing agent. The ammonia was obtained in drums containing approximately 150 lb. These were connected by means of a ¼-in. line with the vapor line, just after the vapor left the stills, and before it reached the first dephlegmator.

At first an attempt was made to use a gas-bubbling bottle containing kerosene, and regulating the flow of the gas by rate of bubbling through the liquid. However, due to the low temperature caused by the expansion of gas as it left the cylinder, the bottles were broken and the oil was also carried over mechanically. In consequence the bubbling device was abandoned and the flow of ammonia required was regulated by examining the water which came to the receiving house from the last dephlegmator in the vapor system. Adjustment was made so that it carried a slight odor of ammonia, or at least was alkaline in reaction. Paper impregnated with phenolphthalein has been found best as an indicator of the character of the water. It was chosen because the color change is quite apparent at night, and regulation at night is as essential as during the day.

This method of regulation is not entirely satisfactory, because at times, due to a slight variation in vapor pressure, the odor comes much stronger than at other times; also, when the drum is getting nearly empty the pressure gets low, and it must be closely watched so that the valve can be opened wider. However, the stillmen have become so adept in handling the regulation that very few samples now come to the laboratory showing an acid reaction.

Comparison of Operations

In order to ascertain the benefits derived from the use of the ammonia in comparison with using none, an average sample of the water which comes from the top of the eighth dephlegmator was analyzed each day over given periods, to determine the iron content. No steam was being used in the system, and the condensed water came from the brine which was originally present in the crude oil. Comparative determinations of iron, in grams per liter of water, as shown in Tables I and II, illustrate the advantage of using ammonia. "Without Ammonia" was using a crude which contained less salt water than the other, and the difference would really have been greater if the same crude had been used as "With Ammonia."

TABLE I. OPERATION WITHOUT AMMONIA

Reaction of water was acid

	Iron Content G. per Liter	Estimated Vol. Water-Liters	Est. Wt. of Iron Lost Kg.	Lb.
1st day	3.65	1,000	3.65	8.1
2nd day	3.88	1,000	3.88	8.6
3rd day	4.55	1,000	4.55	9.8
4th day	4.83	1,000	4.83	10.4
5th day	5.01	1,000	5.01	11.0
6th day	4.85	1,000	4.85	10.5
7th day	7.13	1,000	7.13	15.7
8th day	6.11	1,000	6.11	13.5
9th day	7.87	1,000	7.87	17.3
Average per day			5.18	11.4

TABLE II. OPERATION WITH AMMONIA

Reaction of water was alkaline

	Iron Content G. per Liter	Estimated Vol. Water-Liters	Est. Wt. of Iron Lost Kg.	Lb.
1st day	0.03	4,000	0.12	0.3
2nd day	0.02	4,000	0.08	0.2
3rd day	0.77	5,200	0.40	8.8
4th day	1.20	6,400	7.68	16.9
5th day	0.11	7,600	0.83	1.8
6th day	0.04	8,800	0.35	0.7
Average per day			2.18	4.8

At first the average sample sometimes came to the laboratory having an acid reaction, due to difficulties in regulating the flow of ammonia. Over a period of five months these showed an average of 0.75 g. iron per liter water, while the total average, including the days when the water was alkaline, was only 0.35 g. Thus the water should be alkaline all of the time, not only to prevent corrosion by the acid vapors, but also the action on the metal of the ammonium chloride, which is corrosive in an acid system.

Salt Incrustations

That the ammonia and hydrochloric acid really react and form ammonium chloride has been proved by analyses of various deposits found in the vapor system. In fact, one line was found almost completely closed with a deposit, the composition of which is shown in the first analysis of Table III. The deposits found were variable.

TABLE III. ANALYSIS OF DEPOSITS

	Per Cent
Moisture	0.67
Oil	1.07
Carbonaceous matter	1.20
NH_4Cl	5.38
$FeCl_2.4H_2O$	3.42
Iron oxide (by diff.)	88.26
	100.00
Moisture	1.77
NH_4Cl	69.50
$FeCl_2.4H_2O$	25.14
Undet. and iron oxide	3.59
	100.00

as shown in the second analysis of materials found in the vapor system. We have also found small amounts of ammonium chloride in the vapor line leading from the last dephlegmator to the tubular condenser.

About a year after the use of ammonia was begun the vapor pressure was found higher than normal in the vapor system. An investigation showed it might be due to deposition of NH_4Cl. The next to the last dephlegmator was accordingly washed with warm water and approximately the following amounts of material removed:

	Lb.
Ferrous chloride	102
Ammonium chloride	459
Insoluble matter	23

This is further proof of the reaction between the acid and ammonia and shows that the deposited NH_4Cl and $FeCl_2$ must occasionally be removed. The $FeCl_2$ and

[1] Chem. & Met. Eng., vol. 22, No. 11, p. 491.
[2] *Chemiker-Zeitung*, vol. 43, No. 149, p. 587.

insoluble matter (iron oxide) shows there is still some corrosion even when ammonia is used, but the longer life of the condensers as shown below is clearly indicative of the benefit derived.

Decrease in Depreciation

Before using the ammonia the tubular condenser was in use for approximately 100 days before it was necessary to replace any tubes, but after using ammonia it was about 280 days before any tubes had to be replaced. Not only is the cost of the tubes to be considered, but also the necessary labor and inconvenience sometimes caused. Where condensers are not in parallel it would mean shutting down the unit while new tubes were put in.

The cost of installation is small, and the main expense of course is for ammonia. It will probably vary with market conditions, but when using Mid-Continent crude oil it should not be over $0.005 per bbl. of oil run.

Determination of the water content of the crude oil in each tank before running, and the amount of salt in the oil, have been found of assistance. In connection with determination of the salt content a special method has been developed so that the amount present can be found without the necessity of waiting until sufficient brine separates from the crude. The method has been found very useful on crudes where the brine is present as a semi-permanent emulsion. Also, as stated before, the amount of iron in the water coming from the last dephlegmator is determined each day by analyzing an average sample for twenty-four hours.

Use of Soda Ash Not Successful

While the cost of using ammonia is not excessive compared to the benefit derived, it does, of course, mean an added refining expense. With the idea of reducing the cost, an attempt was made to prevent the formation of the hydrochloric acid by the addition of soda ash to the oil itself, the idea being to get the old familiar reaction between the magnesium chloride and soda ash. A solution of approximately 15 deg. Bé. was prepared and at first was put into the suction line of the feed pump, with the idea of getting as thorough mixing as possible. A proportional pump was used in adding the solution so approximately the proper amount could be added. However, the solution froze on contact with the cold oil and caused pump trouble. A connection was then made so that it could be added to the oil after the oil had been through one heat exchanger. The amount of solution added was so small, though, that even with the line covered the solution froze in the line before it reached the warm oil at the heat exchanger.

A 1-in. line inside of a 2-in. steam line was next tried, and while it fed in fairly well, the flow was intermittent and thus was not entirely satisfactory. In addition we found that even when the soda ash was going into the crude the water from the last dephlegmator was still slightly acid. This seemed due to organic acids collected from the vapor by the water and to carbonic acid. Samples of non-condensible gas were collected and analyzed when ammonia was not being used. They were found to contain 10 to 15 per cent CO_2. As the ammonia effected complete neutralization, it was of course a point in favor of its use. In addition, the use of soda ash apparently increased the amount of salts deposited in the retorts of the pipe still. In view of the above the attempt to use soda ash was finally abandoned and the addition of ammonia was continued.

Experiments which have been lately made show that the aqueous solution of ammonia is cheaper than the anhydrous, and we shall probably be using it exclusively in the near future.

We have not as yet been able to isolate the organic acids referred to above, neither have we been able to locate the source of carbon dioxide which we have found in the vapor system. However, we are proceeding with an investigation as rapidly as routine work will permit.

Roxana Petroleum Corporation,
Wood River, Ill.

Will Sodium Fluoride Come Into General Use for Preserving Wood?

By George M. Hunt

THE desirability of sodium fluoride as a wood preservative is practically established. The data collected by the Forest Products Laboratory and published in the article by C. H. Teesdale on "Use of Fluorides in Wood Preservation"[1] are strong evidence to this effect. One large coal-mining company has been using sodium fluoride since 1915 for the treatment of its mine timbers, in preference to either coal-tar creosote or zinc chloride. In the 1919 *Proceedings* of the American Wood Preservers' Association, pages 138 to 145, Galen Wood, chemist of the Port Reading creosoting plant, presents evidence of the preservative value of sodium fluoride and the practicability of its use.

In spite of its proved value for the purpose, sodium fluoride is not being used to any extent as a wood preservative except by the single company mentioned. Other companies have expressed an interest in it, but they have never used it in quantity. The reason for this is obvious when the price of sodium fluoride is compared with that of zinc chloride, which is the standard water-soluble wood preservative. At present sodium fluoride is selling at about 15c. per lb., while zinc chloride is purchased in large quantities at approximately 8c. per lb. This difference in price prevents the wide use of sodium fluoride in the wood-preservation industry.

Use of Zinc Chloride

Some idea as to the field which might be opened to sodium fluoride in this industry may be obtained from Table I, compiled from the 1919 *Proceedings* of the American Wood Preservers' Association, which gives for a number of years the annual consumption of zinc chloride in preserving wood and the amount of wood treated with it.

TABLE I. AMOUNT OF ZINC CHLORIDE USED IN THE U. S. AND WOOD TREATED WITH IT FROM 1909 TO 1918

Year	Zinc Chloride Used, Lb.	Amount of Wood Treated,* Cu.Ft.
1909	16,215,107	32,678,797
1910	16,802,532	34,804,557
1911	16,359,797	36,814,039
1912	20,751,711	37,803,341
1913	26,466,803	44,772,287
1914	27,212,259	57,352,587
1915	33,269,604	62,849,901
1916	26,746,577	52,075,638
1917	26,444 689	54,311,726
1918	31,101,111	60,385,421

* These figures include wood treated with straight zinc chloride solution and wood treated with mixtures of creosote and zinc chloride.

Assuming a uniform cost of 8c. per lb., the amount of zinc chloride used in 1918 represented a value of

[1] *Wood Preserving*, January-March, 1917.

nearly $2,500,000. At pre-war prices for zinc chloride, the value of this amount would have been in the neighborhood of $1,250,000.

Of the various forms of timber treated with zinc chloride, nearly 95 per cent is in the form of railroad ties, and most of the remainder is construction timber. Small amounts are occasionally reported as used for poles, piling, wood paving blocks, cross-arms and miscellaneous lumber. Reports of the total amount of timber treated in the United States in 1918, the latest year for which statistics are available, show that nearly one-half was treated with zinc chloride.

Since zinc chloride is soluble in water, it will leach out if the treated wood is used in water or very wet locations. It finds its greatest use, therefore, in the drier parts of the country. In the Southern states coal-tar creosote is used in preference to zinc chloride particularly in treating piling to be used in water.

Advantages of Sodium Fluoride

Sodium fluoride can be used in the same manner, with the same apparatus and for the same wood-preserving purposes as zinc chloride. It possesses several minor advantages, but its superiority over zinc chloride for general use is not sufficient to justify the wood preserver in paying a much greater price for it. A comparison of some of the properties of these two chemicals which are of importance from a wood-preserving standpoint is given in Table II.

TABLE II. COMPARISON OF PROPERTIES OF ZINC CHLORIDE AND SODIUM FLUORIDE

	Zinc Chloride	Sodium Fluoride
Solubility in water	Soluble in all proportions	Soluble to about 4 per cent
Toxicity	Toxic enough to materially increase the life of wood	Over twice as toxic as zinc chloride.
Corrosive effect on steel	Somewhat corrosive, but is commonly used in steel apparatus	Much less corrosive than zinc chloride
Effect on paint	Cannot be successfully painted over	Does not injure paint
Convenience of shipping	Shipped in 50 per cent solution or solid, but solid form is deliquescent and must be sealed in air tight containers	Shipped as dry powder in slack cooperage
Present cost	About 8c. per lb.	About 15c. per lb.

From the fact that the toxicity or poisoning property of the sodium fluoride is given as more than twice that of zinc chloride, it might be argued that it would be twice as effective as a preservative, or that only one-half as much need be injected into the wood to produce the same effect. The toxicity is determined by laboratory tests only. Such test must be backed up by service tests, where timber is treated and put into actual use, before it can be determined positively that the relatively smaller amount of sodium fluoride indicated by the toxicity tests can be safely used. Tests of this kind are under way, but it will be a number of years yet before the results are known.

Question of Relative Price

The extent to which sodium fluoride will be used in treating wood, therefore, will depend mainly upon its price. There is little doubt that large contracts for sodium fluoride would be placed if the purchaser could be assured of a price equal to or less than that of zinc chloride. If sodium fluoride should begin to compete sharply with zinc chloride, the price of the latter would probably fall. Lowering prices of these two preservatives would encourage treatment and result in a larger volume of treated timber.

The question as to whether it is possible to manufacture sodium fluoride at a price low enough to compete with zinc chloride was recently answered as follows by a man very familiar with manufacturing conditions: ". . . you must consider that fluorspar which formerly cost about $10 now costs about $50, and hardly enough of 'acid quality' is obtainable for this enormous price. Soda ash costs more than twice as much as it formerly cost. Pyrite for the manufacture of sulphuric acid is also much higher than formerly. To this increase in the cost of all material entering into the manufacture of sodium fluoride comes the cost of labor, which has more than doubled in the last years. The cost of construction and repairs is also at least twice what it was formerly. Considering all these factors, the present price of sodium fluoride is very moderate. We are well aware that at present prices sodium fluoride can compete with zinc chloride for special purposes only. This applies to sodium fluoride made from hydrofluoric acid and soda ash."

From this it is evident that there is no apparent possibility of manufacturing sodium fluoride from fluorspar very cheaply under present conditions.

In the manufacture of fertilizer from phosphate rock, it is possible to recover a certain amount of sodium fluoride from the waste gases produced in the process. This is being done in a small way, but it is not a simple process, and a number of plants which have considered it have been deterred from the undertaking because of the chemical difficulties involved, the cost of constructing the required plant, or the difficulty of obtaining labor and materials. This industry offers a possible future source of cheap sodium fluoride; and although at present it is not producing much, it is to be hoped that the time is coming when it will be possible to furnish the wood-preserving industry with an ample supply at an economical price.

The ingenuity of our chemists should make available for general use a material having such desirable wood preserving properties.

Section of Wood Preservation,
Forest Products Laboratory,
Madison, Wis.

New Paper Pulp Industry in Argentina

The first factory in Argentina to make paper pulp was to begin operations during September, reports Trade Commissioner Brady, of Buenos Aires. The mill, which is located near Barranqueras, in the Chaco Territory, on the Parana River, is using as raw products a species of bog grass called "paja brava." This grass grows during the whole year, and is so abundant in the swampy places that it has been considered a nuisance.

At present the mill is equipped to make only pulp in sheets and strawboard for paper boxes. It has a capacity of three tons of strawboard per day. The construction of the mill was begun over two years ago during the war. The owners are German-Argentine and the engineer in charge is an Austrian. The equipment consists of old machinery rebuilt with some machines which were made in the country. It is intended later to increase the equipment in order to manufacture a finer quality of pulp and to obtain a greater production.

There is undoubtedly a good field for a more elaborate wood-pulp mill in the north of Argentina, since an abundance of trees and plants suitable for paper making exist in that region and there is a market for the product in Argentina.

The Fundamentals of the Electrolytic Diaphragm Cell*—III

Relation of Brine Concentration and Temperature to Voltage and Amperage—Cell Lag and Instant Results—Effect of Sulphate of Soda on Carbon Electrodes — Appendix: Calculation of Decomposition Voltage; Theoretical Yields per Ampere-Hour†

BY HUGH KELSEA MOORE

AS HAS been previously stated, it is possible to feed to the cells a salt solution of 99 per cent saturation. This does not mean, however, that the saturation in the inside of the cell will be 99 per cent saturation, for this is rarely the case. Most cells running at average decomposition efficiencies decompose the brine faster than it comes in. The average brine saturation in a cell running 93 to 95 per cent current efficiency varies from 80 to 82 per cent. It might be interesting to see what effect the brine saturation has on the voltage of a cell. To show this Table IX is submitted, illustrated by Fig. 9.

TABLE IX. DROP IN VOLTAGE WITH INCREASING SATURATION

Brine Saturation at 20 Deg. C.	Cell Temp. Deg. C.	Drop in Voltage	Amperes
15	28.0	0.00	1,200
35	27.5	0.06	1,200
50	27.8	0.18	1,200
65	28.0	0.24	1,200
85	27.8	0.28	1,200
90	28.0	0.33	1,200

Lowering the brine concentration in the cell not only uses up power but it tends to make the current electrolyze water, with the resulting liberation of nascent oxygen at the anode with the consequent more rapid

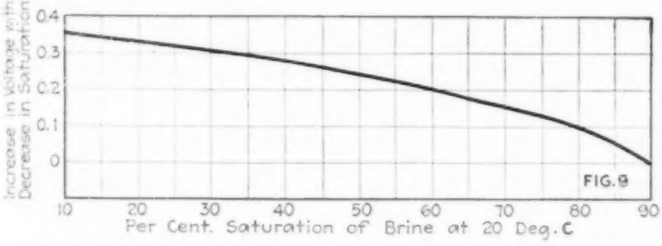


FIG. 9. RELATION OF ANODE BRINE SATURATION TO CELL VOLTAGE. CONSTANT TEMPERATURE

destruction of the carbons. I cannot take the time to go into this now, but will be content with reference to the rapid destruction of the carbons. (See Table VIII, and Fig. 8C.)

EFFECT OF TEMPERATURE ON VOLTAGE AND AMPERAGE

It is often difficult to evaluate the effects of brine concentration because of the disturbing effect of another variable—viz., temperature. To illustrate this I submit Table X and Fig. 10.

The abscissæ are temperatures in degrees C., while the ordinates show the decreases in voltage. Another set of ordinates show the per cent saturation of the brine at the varying temperature. The solid line shows the per cent saturation at 20 deg. C. The dash line corresponds to 640 amp., while the dot and dash line corresponds to 850 amp. It will be noted that these lines are nearly

TABLE X. BRINE TEMPERATURE INCREMENTS AND CELL VOLTAGE DECREMENTS

Brine Temp., Deg. C.	Saturation at 20 Deg. C.	Cell Volts	Decrease in Voltage	Amperes
26.8	81.5	3.40	0.50	640
30.0	81.0	3.36	0.46	640
36.8	80.5	3.28	0.38	640
44.0	.....	3.20	0.30	640
50.0	.....	3.14	0.24	640
57.5	75.0	3.08	0.16	640
68.0	70.0	3.00	0.10	640
82.0	65.0	2.90	0.00	640
33.5	81.0	3.70	0.80	850
41.5	.....	3.52	0.62	850
52.8	77.0	3.40	0.50	850
48.0	.....	3.46	0.56	850
57.5	75.0	3.34	0.44	850
61.0	.....	3.30	0.40	850
76.0	68.0	3.20	0.00	850

parallel, showing in each case approximately the same degree of drop. The solid line is inserted into this chart to show the concentrations in this particular experiment, but as the concentration and temperatures may vary independently of each other, this curve must not be used to predict a concentration at a given temperature.

In order to get the effects of temperature on voltage two experiments were conducted with the object of keeping the concentration constant. Table XI, illustrated by Fig. 11, and Table XII, illustrated by Fig. 12, show the results obtained.

TABLE XI

Brine Temp., Deg. C.	Saturation at 20 Deg. C.	Cell Volts	Decrease in Voltage	Amperes
33.0	88.0	4.24	0.69	1,200
39.0	87.0	4.05	0.50	1,200
47.0	86.5	3.95	0.40	1,200
54.5	85.5	3.80	0.25	1,200
57.5	85.0	3.75	0.20	1,200
61.0	85.0	3.72	0.17	1,200
70.0	84.0	3.60	0.05	1,200
75.0	83.0	3.55	0.00	1,200

TABLE XII

Brine Temp., Deg. C.	Saturation at 20 Deg. C.	Cell Volts	Decrease in Voltage	Amperes
39.0	85.0	3.86	0.41	1,000
47.5	86.0	3.75	0.30	1,000
51.0	85.0	3.70	0.25	1,000
55.5	85.0	3.66	0.21	1,000
59.5	85.0	3.58	0.13	1,000
65.5	84.0	3.50	0.05	1,000
71.0	84.0	3.45	0.00	1,000

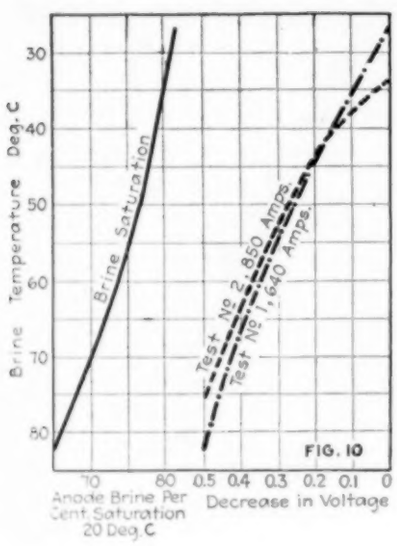
In each case the abscissa is the brine temperature in the anode compartment while the ordinates represent the decrease in voltage. As before, the solid line represents the concentration of the brine, while the dash line shows the drop in voltage. The saturation in Figs. 11 and 12 has been maintained by adding solid salt. The temperatures were obtained by blowing steam into the cell.

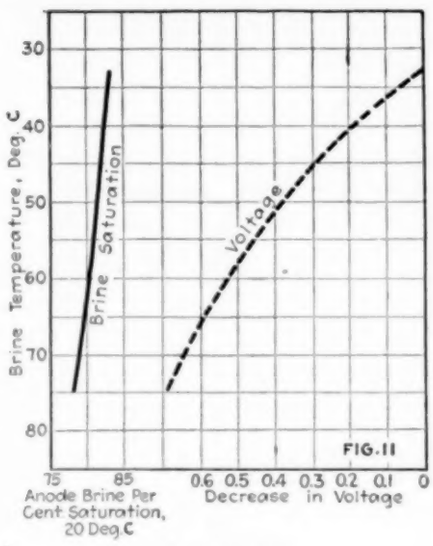
Raising the temperature in a cell also increases the fluidity of the brine and consequently it is well that we should know the effect.

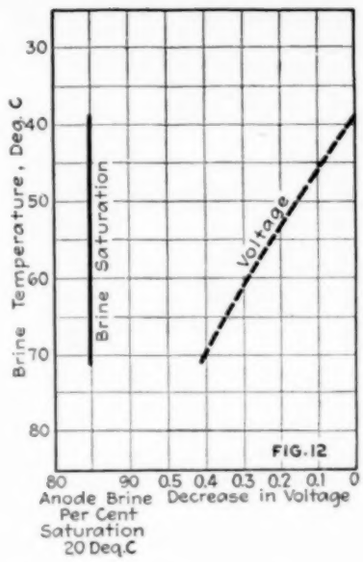
The experiments illustrated by Tables X, XI and XII were conducted on especially high voltage cells in order that the increased flow due to rise in temperature should

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

†For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 21 and 22, Nov. 24 and Dec. 1, 1920, pp. 1,011 and 1,072.


Brine Temperature Deg. C
Brine Saturation
Test No. 2, 850 Amps.
Test No. 1, 640 Amps.
FIG. 10
Anode Brine Per Cent Saturation 20 Deg. C
Decrease in Voltage





FIGS. 10 TO 12.

Fig. 10. Anode brine temperature vs. cell voltage with constant saturation. Figs. 11 and 12. With decreasing saturation.

not be so great as to modify the other characteristics too markedly.

This brings up another matter, the increased flow due to temperature. Table XIII and Fig. 13 show this effect in a striking manner.

TABLE XIII

Brine Temp., Deg. C.	Flow in Liters	Amperes
39.0	11.7	1,000
47.5	12.2	1,000
59.5	14.8	1,000
71.0	20.2	1,000

TABLE XIV. EFFECT OF STEAM ON ALLEN-MOORE CELL NO. 43

Volts	Amperes	Causticity	Grams per L.	Chlorate	Anode Temp.	Anode Sat.	Cathode Temp.	Flow L.p. Hour	Specific Gravity	Decomposition	Eff.	Time
4.0	1180	41.0	164	0.28	46.5	73	32.0	10.2	1.2083	65.4	94.8	9 a.m.
3.92	1200	39.5	158	0.14	46.5	73	31.5	10.2	1.2104	64.6	89.8	10 a.m.
3.8	1225	37.5	150	0.28	55.5	68	34.0	11.8	1.2073	64.2	96.7	11 a.m.
3.8	1200	35.0	140	0.28	58.5	66	35.0	13.0	1.2023	61.5	101.0	12 m.
3.7	1235	31.0	124	0.10	66.0	66	40.5	15.0	1.1769	59.0	101.0	1 p.m.
3.7	1225	29.5	118	0.00	67.5	64	43.0	15.6	1.1750	57.2	101.0	2 p.m.
3.65	1235	28.0	112	0.00	68.5	63	43.0	16.3	1.1749	56.0	98.3	3 p.m.
3.7	1250	28.0	112	0.00	70.0	63	45.5	16.8	1.1741	56.5	101.0	4 p.m.

TABLE XV. EFFECT OF STEAM ON ALLEN-MOORE CELL NO. 43

Temperature	Sp Gr.	Chlorate	Causticity	Volts	Amp.	Flow-L. per Hr.	Eff.	Time
(Without) 24.0	1.2104	0.45	35.0	3.52	775	7.6	91.9	10 a.m.
(With) 27.0	1.2063	0.26	30.0	3.32	775	11.4	122.5	11 a.m.
30.5	1.1954	0.26	26.0	3.22	775	12.6	113.7	12 m.
33.0	1.1866	0.12	24.0	3.25	775	12.1	100.3	1 p.m.
35.5	1.1798	0.0	20.0	3.15	765	14.9	117.0	2 p.m.
40.5	1.1703	0.0	18.5	3.08	775	17.8	113.0	3 p.m.
46.5	1.1675	0.0	16.0	3.02	775	18.6	104.0	4 p.m.

TABLE XVI. EFFECT OF STEAM ON ALLEN-MOORE CELL NO. 43

Volts	Amperes	Causticity	Grams per L.	Flow L. per Hr.	Decomposition	Specific Gravity	Anode Sat.	Eff.	Cathode Temp.	Time
3.3	795	22	88	14.0	46.3	1.1820	65	102	32.5	9 a.m.
3.2	795	20	80	17.0	42.3	1.1720	65	114	36.0	10 a.m.
3.4	900	19.5	78	16.3	42.5	1.1670	65	95.2	38.0	11 a.m.
3.4	900	22	88	16.8	46.5	1.175	65	109	38.0	12 m.
3.5	900	24	96	13.8	50.4	1.180	65	98	35.0	1 p.m.
3.58	900	26	104	13.6	52.2	1.182	65	105	34.5	2 p.m.
3.6	900	26	104	13.2	52.3	1.184	65	100	33.5	3 p.m.

In order to illustrate still further the effect of temperature on a diaphragm cell Tables XIV, XV and XVI and Figs. 14, 15 and 16 are submitted, showing the effects of blowing steam into the cell on the different factors noted. I wish to particularly call your attention to the decrease of chlorate in caustic liquor with the increase in temperature. In all probability this may be accounted for by the increased activity of the nascent hydrogen at the cathode on the decreased stability of sodium chlorate.

Cell Lag and Instant Results

On page 1074 I spoke of the possibility of getting more than theoretical efficiencies on tests of short intervals of time. I mentioned at this time one cause which would make it possible to obtain such results.

In Fig. 14 you will see another illustration of this fact, but for another cause—i.e., the lag in the cell. In the case before you we have a beautiful illustration of this fact. It will be noticed that during the experiment the causticity dropped from 35 to 16, while the flow increased from 7.6 to 18.6. The above condition always

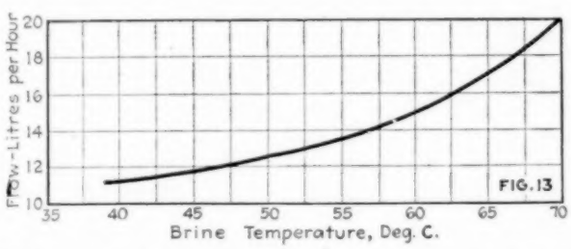


FIG. 13. RELATION OF FLOW FROM CELL TO BRINE TEMPERATURE

gives an apparent efficiency higher than the actual, and as the actual is near 100 per cent the apparent efficiency will be over 100 per cent. There is in every cell a certain volume of caustic held by capillary attraction in various parts of the cathode compartment. Now if one volume of the strong caustic so held is replaced by a light volume of a weaker caustic, the caustic effluent will contain more NaOH than was actually produced during the time in question.

While I am speaking of the high efficiencies of cells I might mention that the same effect will be produced if the cells run at an abnormally high amperage just before a test and then drop to normal as the test commences. I have known some crooks to do the above purposely for a joint test. This causes a high efficiency due

to the lag in the strong caustic getting away. Of course if these conditions are reversed you get efficiencies correspondingly low.

The above considerations are based on cells in which the amperage is accurately determined.

In studying Fig. 16 it will be seen that there is a rise in voltage on the second hour, even though there is a rise in temperature. This is due to a rise in amperage at the same time. The volts continue to rise but it will be noticed that the temperature drops while the amperage remains stationary. It will be noted also that the brine in the anode compartment is only 65 per cent saturation.

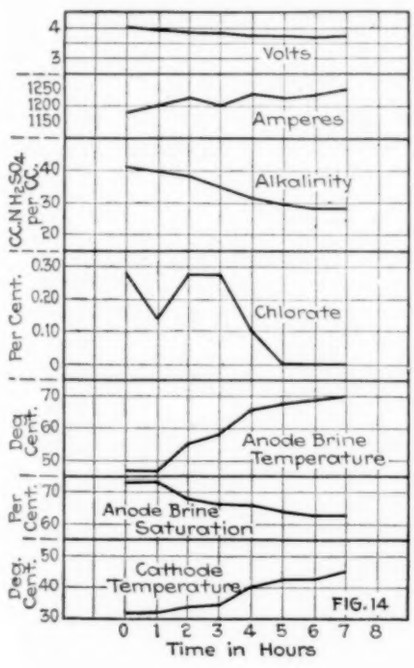
Effect of Sulphate

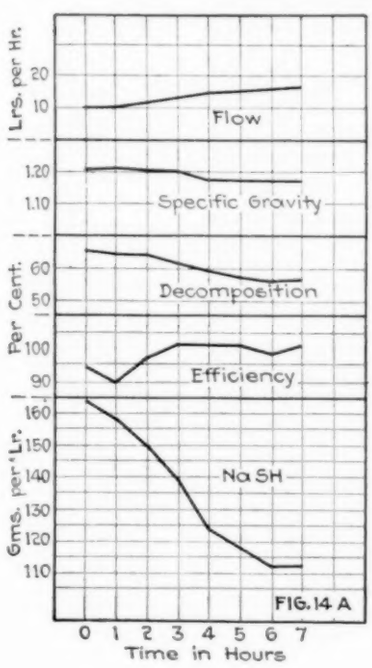
Many do not realize that small quantities of sodium sulphate in the salt fed to the cell can have a deteriorating effect on the cell itself. Experiments have shown that the absolute removal of sodium sulphate from the brine actually decreases the amount of carbon dioxide in the chlorine gas. The presence of this carbon dioxide in the gas not only causes a loss of brine in making bleach but it indicates a deterioration of the carbons in a cell. The loss from the carbons is, however, much greater than one would suppose from the amount of carbon dioxide in the gas. The explanation is simple. As that carbon going into carbon dioxide is removed from the structure of the carbon the cohesive force of other particles is lessened and they sluff off by the friction of the circulating electrolyte.

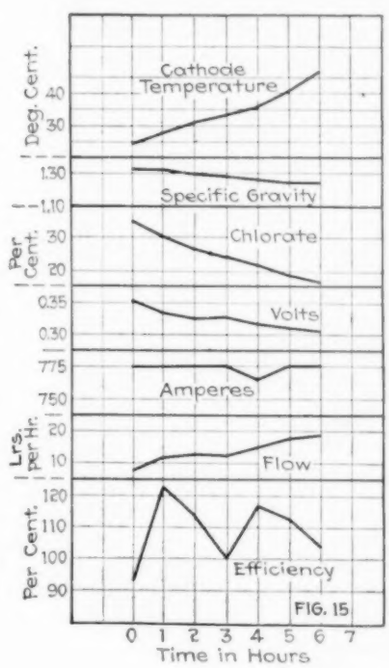
From the above one would expect that the absolute removal of sodium sulphate from the brine would increase the life of the carbons. Actual experiment has proved such to be the case. I am not, however, going to give these figures, inasmuch as I have not tried enough experiments to get an average figure which I can term reasonably correct.

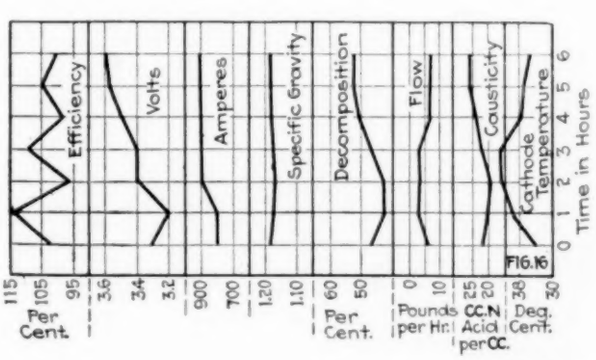
It might be interesting to note the increasing amount of chlorate formed in a cell of the submerged diaphragm type by the addition of a brine containing 1 per cent and 2 per cent sodium sulphate. Fig. 17 shows this. Inasmuch as the lag in the cell is very large and the cell had not reached equilibrium owing to the short time of run, I cannot give you a chart showing the per cent of chlorate which would uniformly be present for different percentages of sodium sulphate. The matter, however, is very important, inasmuch as herein lies a great source of danger to say nothing of expense.

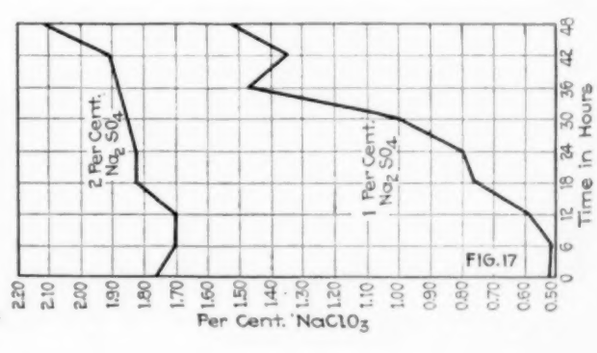
In evaporating a caustic solution it is possible to crystallize out most of the salt but impossible to crystallize out the sodium chlorate. When the kettles containing such chlorate become heated to a sufficient temperature, the sodium chlorate is liable to explode, throwing tons of molten caustic on the floor. Even if the kettles are so run that the sodium chlorate decom-











FIGS. 14 TO 17.

Figs. 14 to 16. Effect of steam on Allen-Moore cell. Fig. 17. Effect of Na_2SO_4 solution on Le Sueur cell.

poses gradually and smoothly, we may have a low test caustic from the presence of sodium chloride formed by the dissociation of the sodium chlorate.

Appendix

Calculation of Decomposition Voltage

It was stated by Helmholtz in 1847 and W. Thompson in 1851 that in a galvanic element chemical energy is completely transformed to electrical energy. Then if the heat of reaction in calories per gram-equivalent is called U, the electromotive force in volts which could be produced by it E,

$$E = \frac{U}{23046} \qquad (1)^1$$

This is often approximately true, its error depending on the temperature coefficient of the electromotive force, and this in turn on the difference of the molecular heats of the reacting substances and the resultant substances. The theoretical basis of the correct method was established by Gibbs and Helmholtz somewhat later, but the new equations were of little use until Nernst's heat theorem was applied to the problem. The result may be written in the form:

$$E = \frac{U - 2BT^2}{23046} \text{ (approx.)} \qquad (2)$$

Where T is the absolute temperature, in Centigrade degrees, and $B = \frac{1}{2T}$ (*specific heat of all the reactants per gram equivalent)—(specific heat of all the resultants per gram equivalent)*. But to apply even this expression, calculations must be made on a basis, first, of each phase being a pure solid or liquid substance; not, for instance, a solution. In the case of the ordinary electrolytic chlorine cell, for instance, the required specific heats must be known at a temperature at which the hydrogen and chlorine are liquid, and the salt and caustic are solid $NaCl.2H_2O$ and $NaOH.7H_2O$ respectively. The requisite correction to bring up the results to room temperature can then be made on the basis of the solubility-temperature curves. Such data, however, and especially the specific heats of low temperatures, are known for only a few substances. It is evident, then, that with the physical data now obtainable, the accurate calculation of decomposition potentials is impossible.

The approximate voltage obtained by equation 1 is, in fact, commonly used in practice. The unknown correction factor may be either positive or negative, and may range from zero to three-tenths, or four-tenths of a volt, or even more. In the case of the chlorine cell it is supposed to be about +0.1 volt.

The heat effects and approximate decomposition voltages of sodium and potassium chlorides in aqueous solution are given herewith, indicating the degree of uncertainty in each case due to conflicting determinations of heat of formation.

Substance	Heat of Formation MCl = M + Cl	Heat of Formation M + H_2O + Aq = MOH + H + Aq	Net Heat Effect Cal. per g. Equivalent	Decomp. Voltage
NaCl	97,900	42,400	55,500	2.41
	to	to	to	Av. 2.35
	97,590	45,000	52,690	2.28
KCl	105,700	45,200	60,500	2.62
	to	to	to	Av. 2.56
	105,610	48,100	57,510	2.50

Brown Company,
Berlin, N. H.

[1] Nernst, "Theoret. Chemistry," Sixth Ed., p. 733.

THEORETICAL YIELDS PER AMPERE-HOUR

Elements

	Lb.	Grams		Lb.	Grams
Sodium	0.00189	0.858	Hydrogen	0.0000823	0.0373
Potassium	0.00322	1.459	Oxygen	0.000644	0.292
Calcium	0.00165	0.747	Chlorine	0.00292	1.322
Magnesium	0.00100	0.453	Bromine	0.00644	2.92
Iron (from Fe")	0.00230	1.041	Antimony	0.00330	1.497
Nickel	0.00242	1.092	Tin	0.00487	2.21
Cobalt	0.00243	1.101	Bismuth	0.00572	2.59
Zinc	0.00269	1.218	Cadmium	0.00461	2.09
Lead	0.00852	3.86	Copper (from Cu")	0.00260	1.18
Silver	0.00888	4.02	Platinum	0.00400	0.34
Gold (from Au")	0.00540	2.45	Aluminum	0.00075	0.34

Inorganic Compounds

	Lb.	Grams
NaOH	0.00329	1.492
KOH	0.00462	2.095
$Ca(OH)_2$	0.00305	1.382
$Mg(OH)_2$	0.00240	1.087
ZnO	0.00335	1.518
CuO	0.00589	2.67
PbO_2	0.00492	2.23
Whitelead (approx.)	0.00631	2.86
$Na_2S_2O_4$ (from $NaHSO_3$)	0.00717	3.25
$Na_2S_2O_5$ (from $NaHSO_4$)	0.00957	4.34
$NaBO_2$ (from borax)	0.00338	0.153
$NaClO_3$ (from NaCl)	0.00146	0.660
$KClO_3$ (from KCl)	0.00168	0.761
Na_2CrO_4 (from $CrCl_3$)	0.00445	2.015
K_2CrO_4 (from $CrCl_3$)	0.00532	2.41
$PbCrO_4$ (from H_2CrO_4)	0.01330	6.02
$NaMnO_4$ (from $NaMnO_4$)	0.01168	5.29
$KMnO_4$ (from K_2MnO_4)	0.01301	5.90
$Na_2C_2O_4$ (from $NaCO_3$)	0.00684	3.10
$K_2C_2O_4$ (from K_2CO_3)	0.00816	3.70
NH_2OH (from HNO_3)	0.00045	0.205
$K_3Fe(CN)_6$ (from $K_4Fe[CN]_6$)	0.0264	11.94

Organic Compounds

	Lb.	Grams
Iodoform	0.00324	1.47
Anthraquinone	0.00428	1.94
Vanillin	0.00208	0.94
Chloral	0.0015	0.69
Saccharine	0.00252	1.14

British Power-Alcohol Research

It is reported that detailed research is shortly to be undertaken in India with a view to determining the practicability of producing power alcohol on a commercial basis, reports A. M. Walker, clerk to American Trade Commissioner, London.

At the same time that these experiments are being conducted, efforts are being made in Great Britain to make possible the ready use of such a substitute fuel whenever it becomes available in sufficient quantities. With this object in view, the Empire Motor Fuels Committee of the Imperial Motor Transport Council has recently appointed small technical committees to consider specifically:

(1) The modification of customs and excise regulations pertaining to alcohol;

(2) Experiments for determining the best conditions for developing the alcohol engine and types of alcohol fuels, alone or in mixture, for industrial purposes; and

(3) The denaturing of alcohol.

The problem of ascertaining what is a suitable denaturant is regarded as of very great importance, and the Empire Motor Fuels Committee, 50 Pall Mall, London, S. W., 1, has invited in confidence interested members of the public to submit practical suggestions as to possible denaturants. Such proposals will remain the sole property of the individual who furnishes them, and his interests will be properly safeguarded. The special requirements of a satisfactory denaturant, according to the committee, are (1) deterrent taste and smell; (2) non-poisonous; (3) must not be removable at a commercial cost; (4) must be readily detectable in small quantities; (5) must be readily mixable with the spirit, and (6) must be inexpensive.

Legal Notes

By Wellington Gustin

Fertilizer Manufacturers Should Watch Their Sales Contracts

In a suit by the Montezuma Fertilizer Co. against B. C. Hodges, the action resulted from a purchase by Hodges of certain fertilizers under a special formula furnished by the buyer, whereby it was agreed that the nitrogen was to be derived from "equal parts of fish scrap, blood and tankage." This fertilizer was shipped out under the registered brand "840." This brand "840" as registered with the Commissioner of Agriculture of Georgia is there stated to derive its nitrogen from "blood, tankage, cyanamide and sulphate of ammonia." A properly certified copy of the official analysis of this fertilizer "840" as made by the state chemist and furnished to the purchaser showed a deficiency in the phosphoric acid, which resulted in a lessening of the commercial value of the fertilizer amounting to more than 3 per cent. Subsequently, upon the request of the seller, the Department of Agriculture, through the state chemist, rechecked the original analysis from the original samples, and certified the new and corrected analysis, which showed a lessening of the commercial value amounting to less than 3 per cent. The state chemist testified that the corrected analysis was true and correct.

Defendant Charged Fertilizer Was Not as Registered

Upon a suit for the purchase price of the fertilizers sold Hodges set up two grounds of defense: (1) That brand "840," under which name or number the fertilizer was furnished, as registered with the Georgia State Commissioner of Agriculture, stated that its nitrogen was derived from "blood, tankage, cyanimide and sulphate of ammonia," whereas the fertilizer as actually shipped and sued for derived its nitrogen from "equal parts of fish scrap, blood, and tankage," and therefore the sale was illegal and the contract of sale void, inasmuch as the registration laws of Georgia governing fertilizers had not been complied with; (2) that in event the contract should not be adjudged illegal and void, he was still entitled to a reduction of 25 per cent of the price as a penalty, because the official analysis showed that the actual commercial value of the fertilizer fell more than 3 per cent below the guaranty.

Upon trial the Judge held the contract sued on was not void under the first contention given above. He further held the second or corrected analysis to be inadmissible in evidence for the reason the Georgia statute did not provide for any such corrections to be made of an official analysis. Therefore he applied the 25 per cent penalty and gave judgment accordingly.

Appeal by both parties was had and the Court of Appeals of Georgia certified certain questions to the Georgia Supreme Court. In answering the questions the court said that "where a contract for the purchase of fertilizers specifically provides from what source the phosphoric acid, the nitrogen or the potash is to be derived, and where the fertilizers furnished in accordance with such special order, such contract of sale would be void unless the fertilizers so furnished had been registered as provided by Civil Code 1910, Section 1771.

"The fact such fertilizers were furnished as ordered under a name or brand properly registered with the Commissioner of Agriculture, but which registration gives a source other than the actual one from whch the phosphoric acid, nitrogen or potash is derived, would not operate to change the rule above stated."

Court Decides There Was a Variance

And where the brand as registered states that the nitrogen is derived from "blood, tankage, cyanimide and sulphate of ammonia," and the proof shows that in accordance with the contract of purchase the nitrogen is derived from "equal parts of fish scrap, blood and tankage," there is such a variance between the registered sources and the actual sources as would invalidate the contract of purchase, under the statute governing registration of fertilizer brands.

On the question of whether a corrected analysis from the same sample of fertilizer may be made, the court said that after a sample of fertilizer drawn by the official inspector has been filed with the Commissioner of Agriculture and has been analyzed by the state chemist and certified to said Commissioner and by him recorded and entered as official, the State Commissioner of Agriculture has the right and power to make, through the state chemist, another or corrected analysis from the same sample, which upon proper certification is admissible as evidence in the courts of Georgia in the trial of any issue involving the merits of said fertilizers.

Strike Provision in Sales Contract

The principles laid down in the decision of the United States Circuit Court of Appeals, Fourth Circuit, delivered in the case of the Acme Manufacturing Co. against the Arminius Chemical Co. have to do with a strike provision in a sales contract. The case has been up again before the court on a rehearing, but there was no change in the opinion.

The chemical company contracted to sell sulphur pyrites to the Acme company during 1916, the contract being "subject to delays and stoppages caused by strikes accidents, delays by railway companies, and causes beyond the selling company's control."

The chemical company made similar contracts with others, and its entire obligations for deliveries in 1916 amounted to 64,793 tons. In January of that year, after these contracts were made, a cave-in occurred in the mine which prevented delivery of all but 8,977 tons of pyrite, the Acme company receiving but 796 tons under its contract calling for 6,000 tons.

The Acme company contended that an accident, strike or suspension clause in a contract, under circumstances analogous to the present case, does not justify the abrogation of such contract, but does have the effect of suspending performance only, except in cases where such accident or strike renders it impossible of ever being performed. In addition to this the court pointed out that certain letters, passing between the parties relating to postponement of shipments to the year 1917, along with a part performance of the contract by the chemical company, established a contract for shipments during 1917. It was said that even if the provisions of the contract had been such that, under the circum-

stances of this case, it would have expired on Jan. 1, 1917, as the contract provides, the same was extended by the agreement of the chemical company as shown by its letters.

Holding that the buyer is entitled to sue in anticipating a breach, the court said that where, during performance by the seller of a contract to deliver to the buyer a stated quantity of sulphur pyrites in monthly shipments, it expressly repudiated the contract on the ground that it had expired and refused to make further shipments, the buyer had the right at its option to treat the contract as ended and to maintain an action for its breach.

In stating the measure of damages for breach it was said that where the seller repudiated its contract without justification after partial performance, and where the buyer used diligence, but was unable to buy elsewhere under the market price, his measure of damages was the difference between the contract price and the market price at the time and place of delivery.

Strike Provision Does Not Excuse Non-Delivery

On the question of the strike provision in the contract the court laid down the rule that such a strike provision does not excuse non-delivery within a reasonable time after the strike has ended. It was contended that "an accident, strike or suspension clause in a contract has the effect of suspending performance only, and never justifies the abrogation of the contract and the refusal to ever perform it, unless such strike, accident, etc., makes the contract impossible of ever being performed."

In passing upon the point the court in another case, Jackson Phosphate Co. vs. Carleigh Phosphate, etc., Works, 213 Fed., 743, said: " . . . this court held that where one charges himself with an obligation possible to be performed he must make it good, and that unforeseen difficulties, however great, will not excuse him. It was also stated by the court that the rule as announced was subject to the qualification that, where a contract contains a limitation upon an otherwise absolute undertaking, one will be relieved from such obligation 'to the extent that such conditions rendered it unable to perform the contract fully, and to this extent only.' "

The rule as announced in 35 Cyc., 249, was adopted by the court. This statement follows:

" 'Where the contract provides that delivery shall be subject to strike, the existence of a strike merely suspends deliveries during the strike, and does not terminate the contract, and the seller is therefore bound to resume deliveries after a reasonable time after the strike has ceased.' Indeed the rule is so well established that we do not deem it necessary to cite further authorities.

"A careful consideration of the authorities relied upon by the defendant leads us to the conclusion that they do not apply to the case at bar. As we have stated, under this provision of the contract the defendant could have required the plaintiff to make the balance of the shipments within a reasonable time, and, such being the case, we think that such provision likewise inures to the benefit of the plaintiff, and that therefore the plaintiff was entitled to deliver the rock within a reasonable length of time after cars were to be had, and that the effort of the defendant to cancel the contract and its refusal to accept further deliveries under the same entitled the plaintiff to recover the amount sued for in this action."

The court said this rule was now well established in law.

Pro Rata Deliveries on Contracts

Again in the instant case the Acme company contended that the chemical company could not avail itself of the defense of pro rata deliveries on its several contracts. The court said the defendant is entitled to such defense where it finds it impossible, from causes over which it has no control, to fulfill the contract. In such cases defendant is required to do the next best thing, to wit, to apportion the amount available among all its customers, giving to each one his ratable share. This is an exception to the general rule, and is applied only for the relief of an unfortunate defendant who has, by this conduct, shown that he has in good faith made an honest effort to carry out the provisions of his contract. In order to enable one to avail himself of this defense, says the court, it must appear that he has treated all customers with absolute fairness, and it must further appear that in the circumstances he had done all that could be expected from one whose purpose is but fair dealing, giving each of his customers the ratable share to which he is entitled under the contract.

But the court pointed out that of the 13,848 tons of pyrites delivered on its 1916 orders, 11,110 tons were delivered to Caraleigh Phosphate Co., Grasselli Chemical Co. and the Richmond Guano Co., and these three favored customers were the only ones with whom the defendant had made new contracts. In view of these facts the court held that the seller could not escape liability on the principle of pro rata deliveries.

The judgment below was reversed and a new trial granted.

Claim of Noxious Ammonia and Insufficient Content Not Allowed by Court

In the action by the Palmetto Guano Corporation against J. D. McCormick to collect on a note given for the purchase price of thirty-two tons of commercial fertilizer, the defendant alleged in defense of non-payment that the ammonia content of the fertilizer was only 2.7 per cent when the contract was for a 3 per cent ammonia, and that the ammonia present was noxious because it wae derived from a leather product. The trial court directed a verdict for the company and the Supreme Court of South Carolina has affirmed this judgment.

Defendant offered the testimony of an expert witness named Rice to prove that 1 lb. of the fertilizer sent to the witness by McCormick contained only 2.7 per cent of ammonia, that the fertilizer contained a leather product and that the ammonia was probably derived from a leather product. It appears McCormick's whole reliance to defeat a recovery was on the competency of the testimony of Rice to prove a deficiency of ammonia and the noxious character of it.

The Supreme Court pointed out that there was no testimony to show that the 1 lb. analyzed by the witness Rice was taken out of the fertilizer sold by the company to the defendant. And it said had the testimony been admitted it would have tended to show only that out of thirty-two tons of fertilizer 1 lb. of it fell short of the ammonia contracted for by only an inconsiderable amount, and it does not show that the ammonia present was noxious.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process for Coking "Non-Coking" Coals. — After a thorough study of coke-oven phenomena, ARTHUR ROBERTS, of Evanston, Ill., offers the following explanation of the difference between coking and non-coking coals. From this theory he has developed a process for coking coals which have been found unsuitable for the manufacture of metallurgical coke in the ordinary type of coke-oven.

In general coke is formed by binding the fixed carbon and ash constituents of the coal together by means of a cementing material which is made out of and from the resinoid volatile hydrocarbon contained in the original coal. The classification of coals as "coking" or "non-coking" has been based upon results obtained in existing types of ovens. Semi-bituminous coals have been found to yield metallurgical coke, whereas the larger percentage of bituminous coals have failed in this respect. In the so-called "coking" coals, the amount of resinoids naturally present is so large that a sufficient proportion of binding material will be formed almost without regard to the process or manner of application of heat treatment, whereas in the so-called "non-coking" coals, the proportion of resinoids is so small that special consideration must be given to a process producing the heat treatment necessary to increase the production of and conserve the binding material from the resinoids. The binding material must be formed at the right time and under the proper conditions, if coke is to be produced. Opposing these conditions are the tendency for the resinoids to vaporize and escape from the coking mass, and the tendency toward destruction of the resinoids by chemical combinations with other elements present, particularly with oxygen. The influence of the oxygen content and of the hydrogen: oxygen ratio on the classification of coals is clearly shown from typical analyses. Coking coals have less than 10 per cent oxygen and a hydrogen: oxygen ratio (on the dry basis) of more than 0.58. That the hydrogen: oxygen ratio or its reciprocal is a function of the geological age of the coal is shown from the following data:

	Oxygen: Hydrogen Ratio
Wood	6.82
Peat	5.65
Lignite	5.06
Sub-bituminous coal	3.46
Bituminous coal	3.09
Semi-bituminous "coking" coal	1.11
Anthracite	0.61

The disturbing factors referred to are negligible in the case of most "coking" coals on account of the high content of resinoids and the low oxygen: hydrogen ratio, but they exert a controlling influence in the case of "non-coking" coals.

It is evident from a study of heat exchange in a coke-oven that the zone of volatilization of the resinoid materials advances from the sides of the oven toward the center as heat is transferred from the hot walls to the charge and that this zone precedes the formation of coke or what may be termed the coking wave. In treating non-coking coals, the conversion into coke will not occur unless the crest of the coking wave reaches each point in its travel rapidly enough to catch the resinous materials and convert them into cementing material by decomposition before these resinous materials can be oxidized or vaporized. The front of the wave must be steep enough to bring about this conversion, otherwise when the crest of the wave arrives the materials will have been removed from the mass. This involves supplying an amount of heat sufficient to raise the temperature of the whole charge quickly to the most favorable coking temperature. In order to accomplish this the inventor proposes to use a narrower retort and to charge the coal into a heated retort the oven structure of which is so proportioned as to contain an amount of heat sufficient to raise the charge rapidly to 600 to 700 deg. C. The amount of this reserve of heat is partially measured by a comparison of the weight of the walls and hot structure with the weight of the coal, taking account of the specific heat of the walls and structure. In practice, the following proportions have been found to give the best results: Width of retort, 12 to 16 in.; 29 to 30 lb. coal in retort per sq.ft. of heating surface; 12 to 13 lb. coal in retort per sq.ft. of surface in the heating gas passages; approximately 3.8 lb. of wall and wall structure (arranged to give up its heat rapidly on demand) per lb. of coal in the retort. (1,352,696; assigned to American Coke & Chemical Co.; Sept. 14, 1920.)

Anthraquinone by Catalytic Oxidation.—Anthracene in the vapor phase is oxidized by oxygen in the presence of an oxide of vanadium as a catalyzer at a temperature of about 300 to 500 deg. C. (1,355,098; JOHN M. WEISS of New York and CHARLES R. DOWNS of Cliffside, N. J., assignors to The Barrett Co.; Oct. 5, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Acridine Dyes.—Acridine dyes are obtained by heating a mono- or di-formyl derivative of a *m*-diamine of the benzene series with a salt of a monoalkylated or unsymmetrically dialkylated *m*-diamine of the benzene series or with β-naphthylamine hydrochloride, or by heating formyl derivatives of monoalkylated or unsymmetrically dialkylated *m*-diamines of the benzene series or formyl-β-naphthylamine with salts of *m*-diamines of the benzene series or their monoalkylated or unsymmetrically dialkylated derivatives. According to examples, products are obtained from the following pairs of components: 4-formylamino-2-aminotoluene and 3-aminodimethylaniline hydrochloride; 4-formylamino-2-aminotoluene and 4-amino-2-dimethylaminotoluene hydrochloride; diformyl-*m*-toluylenediamine and 3-aminodimethylaniline; 4-formylamino-2-aminotoluene and 4-amino-2-methylaminotoluene; monoformyl-*m*-phenylenediamine and 4-amino-2-ethylaminotoluene; diformyl-*m*-phenylenediamine and 4-amino-2-ethylaminotoluene; 4-chlor-1-amino-3-formylaminobenzene and 3-aminodimethylaniline hydrochloride; 4-formylamino-2-aminotoluene and β-naphthylamine hydrochloride; monoformyl-*m*-phenylenediamine and β-naphthylamine hydrochloride; 4-formylamino-2-dimethylaminotoluene and *m*-toluylenediamine hydrochloride; 4-formylamino-2-dimethylaminotoluene and 4-amino-2-ethylaminotoluene hydrochloride; formyl-β-naphthylamine and *m*-toluylene-

diamine hydrochloride; formyl-β-naphthylamine and 3-aminodimethylaniline hydrochloride; formyl-β-naphthylamine and 4-amino-2-methylaminotoluene hydrochloride. The sulphates, etc., of the diamines may be used instead of the hydrochlorides. The products dye leather yellow to orange red shades. (Br. Pat. 145,802—1919. AKT. GES. FÜR ANILIN-FABRIKATION, Treptow, Berlin, Sept. 1, 1920.)

Purifying Mineral Oils.—A natural or an uncracked oil is desulphurized by vaporizing it and bringing the vapor into contact with granular alumina or ignited magnesite at a temperature below the boiling point of sulphur. The alumina may be prepared from the trihydrate or bauxite. Sulphuretted hydrogen resulting from the dissociation of the sulphur compounds may be absorbed in oxide of iron, Weldon mud, or the like. (Br. Pat. 145,818—1919. J. J. HOOD, London, Sept. 1, 1920.)

Concentrating Ores.—Copper sulphide such as chalcopyrite, carbonaceous material such as graphite or coal, and molybdenite, or any two or more of these substances are separated from other floatable minerals such as sulphides of iron, lead and zinc by an application of the froth-flotation process in the presence of a soluble frothing agent and a small proportion of an alkali, preferably an alkaline silicate. (Br. Pat. 145,852—1919. L. A. WOOD, and MINERALS SEPARATION, LTD., London, Sept. 8, 1920.)

Cellulose Esters.—For the manufacture of cellulose esters of fatty acids, a cellulose is employed which has been preliminarily treated at a temperature not exceeding 30 deg. C. with small quantities of acetic anhydride in presence of a catalyst diluted with glacial acetic acid. Thus, 100 parts of cellulose are treated with 50 parts of acetic anhydride, 3 to 5 parts of sulphuric acid, and 60 parts of glacial acetic acid at a temperature of 25 to 30 deg. C. for three to four hours; 250 parts of acetic anhydride are then added and the mixture maintained at 40 deg. C. for one to two hours to effect esterification. The esters may be separated by precipitation with water, or they may be converted by partial saponification into esters having different solubilities; the precipitated esters are insoluble in chloroform, whereas some of the saponified esters are insoluble in chloroform and soluble in acetone and others soluble in ethyl acetate. (Br. Pat. 146,092—1919. SOC. CHIMIQUE DES USINES DU RHONE, Paris, Sept. 8, 1920.)

Nitrogenous Phosphoric Fertilizer.—A solid nitrogenous phosphoric product suitable as a fertilizer is obtained by converting tricalcium phosphate by heating it with at least an equal quantity of nitric acid, preferably of 50 to 60 per cent strength, into monocalcium phosphate and calcium nitrate, and adding to the thin paste obtained sufficient limestone or other calcium compound or phosphate to neutralize the free acid, and convert the monocalcium phosphate into monohydrogen calcium phosphate. The product obtained is allowed to solidify and is then pulverized. (Br. Pat. 146,097—1919. NITRUM AKT. GES., Zurich, and H. SCHELLENBERG, Personico, both in Switzerland, Sept. 8, 1920.)

Preparation of Methane.—Methane is prepared catalytically by passing a mixture of carbon monoxide and excess of hydrogen through a series of furnaces containing heated contact material, for example, pumice carrying active nickel, the composition of the gases being adjusted at each passage, as for example by the addition of carbon monoxide, so that the amount of the latter does not exceed about one-fifth by volume of the hydrogen present, and the gases being freed from water vapor after each passage through a furnace. Thus, between each pair of furnaces there is provided a condenser, and a connection with a suitable measuring device for introducing a measured quantity of carbon monoxide, the gases used containing originally a large excess of hydrogen. In place of hydrogen, purified illuminating gas may be employed; and for carbon monoxide may be substituted a purified water gas. The traces of hydrogen finally remaining in the gases may be removed by passage over cupric oxide, or the methane may be liquefied by cooling the gases. (Br. Pat. 146,110—1919. FARBWERKE VORM. MEISTER LUCIUS & BRUNING, Hoechst-on-Main, Germany, Sept. 8, 1920. See also Br. Pat. 146,114—1919.)

Production of Calcium Aluminate. — Calcium aluminate is produced by heating coarsely crushed bauxite and limestone at a temperature such as not to cause fritting, for instance in a rotary furnace, and then fusing the mixture in a second furnace. The fused product may be granulated in water. The first heating may be effected by gases from the second furnace. Alternatively, a blast furnace may be employed, the charge consisting of alternate layers of red bauxite (which may contain 32 to 35 per cent of ferric oxide) mixed with limestone and of coke. The aluminate is recovered as a liquid slag and the iron as pig iron. In another modification, a converter is employed. It is charged with pellets of a mixture of bauxite, limestone and coke dust upon a bed of kindled coke. An agglomerated mass of crude aluminate is obtained, which is discharged by tilting the converter. (Br. Pat. 146,133—1919. SOC. ELECTRO-METALLURGIQUE FRANÇAISE, Paris, Sept. 8, 1920.)

Cementation.—Iron and steel are carburized by the action of nascent carbon monoxide under pressure slightly in excess of that of the atmosphere. The metal is packed in a closed chamber, together with a mixture of powdered charcoal and iron and manganese oxides, and heated. The treatment may be repeated at a higher temperature, say approaching 1,200 deg. C. Any low-grade ore which liberates oxygen at a high temperature may be used, or air or oxygen may be supplied. (Br. Pat. 146,504—1919. T. TASHIRO, Tokyo, Sept. 15, 1920.)

Ammonium Sulphate.—A mixture is made of niter cake, sodium sulphate, ammonium sulphate and water under such conditions that a quantity of anhydrous sodium sulphate is separated, and after the removal of this sodium sulphate, the liquor is used for absorbing ammonia from gases. When used for treating Mond gas, the solution is diluted before the absorption of ammonia and then concentrated again. When treating coke-oven gas or coal distillation gas, this dilution and evaporation may be unnecessary. The absorption of ammonia with the subsequent evaporation causes the separation of sodium-ammonium sulphate, which is removed, and a further evaporation causes the separation of ammonium sulphate, the double salt being used with more niter cake for repeating the process. When dilution and evaporation are not employed, the absorption of ammonia causes the separation of ammonium sulphate, the mother liquor being used with more niter cake for repeating the process. (Br. Pat. 146,546—1919. C. W. BAILEY, H. S. DENNY and W. H. H. NORRIS, all of Langwith, Nottingham, and Sir H. E. F. GOULD-ADAMS, Westminster, Sept. 15, 1920.)

Purifying Sulphuric Acid. — Sulphuric acid of strength up to about 150 deg. Tw. is freed from arsenic by treatment with sulphuretted hydrogen under such conditions that the acid itself is not attacked—that is to say, the acid is thoroughly impregnated with the gas, which may be effected in apparatus described in Specification 2,113—1909 at a temperature not above about 18 deg. C. and the precipitate is quickly separated, preferably in a vacuum or pressure filter. (Br. Pat. 146,598—1919. G. K. DAVIS, London, Sept. 15, 1920.)

Fumaric Acid.—Fumaric acid is obtained by fermenting sugars (cane-sugar, dextrose, maltose, etc.) by means of a particular species of *Aspergillus* termed *Aspergillus fumaricus;* a description of this mold is given. The fermentation is effected in the presence of chalk or other neutralizing agents; the resulting calcium fumarate is converted into the free acid by means of sulphuric acid, or is converted into lead fumarate, which is then decomposed by sulphuretted hydrogen. (Br. Pat. 146,411—1919. C. WEHMER, Hanover, Germany, Sept. 15, 1920.)

Synthetic Tanning Agents. — Tanning agents are prepared by sulphonating crude anthracene, crude carbazole or anthracene waste, and decolorizing the sulphonated product by means of chlorine, hypochlorites, oxalic acid, formaldehyde, etc.; the decolorized product is capable of giving a light-colored leather. A similar product is obtained by sulphonating the crude bodies specified above by means of chlorsulphonic acid, preferably in the presence of an inert diluent, such as nitrobenzene, at a moderate temperature; this product may be subsequently treated with decolorizing agents as above described. (Br. Pat. 146,427—1919. BADISCHE ANILIN- UND SODA-FABRIK, Ludwigshafen-on-Rhine, Sept. 15, 1920.)

Obtaining Fats From Sulphite Lyes. — The sugar contents of waste sulphite lyes are converted into fat by growing a fungus *Endomyces vernalis* on the lye. The lye is first treated—for example, by aëration and neutralization—and is then inoculated with the fungus whose early growth may be assisted by adding nitrogenous substances such as beet juice to the waste liquor or by first growing the fungus in a culture-medium rich in nitrogen and then transferring it to the lye. The first stage of the process is marked by a large absorption of nitrogen and by rapid growth of the fungus. During the second stage the sugar in the lye is assimilated and converted into fat, and the growth of the fungus is slight. The masses of fungi are finally removed from the solution and treated for the recovery of fat. (Br. Pat. 146,430—1919. W. JEROCH and REICHSAUSSCHUSS FÜR PFLANZLICHE UND TIERISCHE OELE UND FETTE GES., Berlin, Sept. 15, 1920.)

Fats.—Fats are produced from nutrient media which contain carbohydrates, nitrogenous substances and salts by growing in the media micro-organisms such as aërobic mold-fungi, mildews and yeasts—e.g., *Oïdium, Sachsia* or *Endomyces* species. The fungi are grown on substrata saturated with the nutrient solution or in the solution itself which is aërated. Injury to the organisms by acids formed during the reaction is prevented by neutralization. As soon as the 'vegetation" period is completed the fungi are subjected to a "fasting cure" and the fat formed is extracted in the usual manner—e.g., by pressure or by solvents. (Br. Pat. 146,431—1919. REICHSAUSSCHUSS FÜR PFLANZISCHE UND TIERISCHE OELE UND FETTE GES., Berlin, Sept. 15, 1920.)

Saccharifying Cellulose. — Soluble carbohydrates obtained from materials containing cellulose by treatment with concentrated sulphuric or hydrochloric acid, are, after lixiviation in a counter-current, separated from the conversion acids by a diffusion process similar to the "molasses osmose" process. Sufficient acid is allowed to remain with the carbohydrates for complete hydrolysis during subsequent heating, or the acid may be removed as fully as possible, and the solution neutralized, evaporated to dryness and used as fodder. (Br. Pat. 146,455—1919. A. WOHL, Danzig, Sept. 15, 1920.)

Treating Waste Gases From Coke Ovens. — To separate into their constituents the waste gases from coke ovens which remain after the recovery of the tar, benzene, ammonia, etc., the gases are first highly compressed and treated for the removal of water and carbonic acid, then compressed further if necessary and cooled to liquefy all the remaining constituents except hydrogen, and the condensate fractionated to obtain nitrogen, carbon monoxide, methane and ethylene. Alternatively, the gases may be compressed and washed with water or other absorbent for the removal of carbonic acid and then with a solution of common salt or with alcohol or acetone for the recovery of ethylene, and afterward dried and liquefied as before. The absorption liquid may be selected so as to absorb two different gases, for instance ethylene and carbon dioxide, which is convenient if these gases are subsequently to be brought to mutual reaction. The gases given off during the different stages of the coking process may be collected separately and treated according to their composition, and it is more economical to replace the waste gases used for heating the ovens by other gases, such as producer gas, water gas or furnace gas. (Br. Pat. 146,839—1919; BOMBACHER HÜTTENWERKE, Coblenz, Germany, Sept. 22, 1920.)

Crucibles for Melting Aluminum. — Crucibles of graphite, iron or steel, or clay, for use in melting aluminum and aluminum alloys, are provided internally with a coating of aluminum bronze varnish before each melting operation, from which coating the varnish is burned out by heating slowly to about 400 deg. C. The aluminum coating becomes oxidized during the melting operation. The lid of the crucible may have its interior similarly treated. (Br. Pat. 146,841—1919; METALLINDUSTRIE SCHIELE & BRUCHSALER, Hornberg, Schwarzwald, Germany, Sept. 22, 1920.)

Preparation of Pure Starch From Rice.—To prepare pure starch from rice without the aid of caustic alkali or common salt, the rice is first steeped for a few hours in cold or lukewarm water until sufficiently softened; the steeped rice is subjected to wet grinding until 98 per cent of the grist passes through a silk having a mesh of 130 × 130, water being added during the grinding so as to form a paste or cream containing about 38 to 40 per cent of dry solids; and finally the ground mass is diluted with water to a density of 18 to 25 deg. Tw. and the starch separated centrifugally, or to a density of 1.5 to 2 deg. Tw. if separation by decantation is employed. The residue, which is rich in albuminoids, forms a cattle food. (Br. Pat. 147,255—1919; RECKETT & SONS and C. H. HARDY, Hull, Yorkshire, Sept. 29, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Shows Gas to Be an Important Weapon

That military gases played a very important part during the World War is shown by the report just made to Congress by the Surgeon General of the Army. It shows that approximately one man out of three that entered the hospitals of the American Expeditionary Forces was gassed. Enemy gas caused 72,056 casualties, of which 1,271 died. Thus one man out of fifty-seven lost his life. On the other hand, there were 160,783 casualties from battle causes other than gas. From those casualties one out of thirteen died. This does not include the 34,249 men who were killed outright on the battlefield. If they were included, the deaths would be approximately one to three wounded.

Based on the average total strength of officers and men in the American Expeditionary Forces, the number of men gassed was 67.5 per thousand. Of those wounded by rifle and machine gun bullets there were 19.5 per thousand. Wounds from high explosive shells number 16.7 per thousand. The shrapnel wounds were 32.3 per thousand, and wounded by bayonet 0.22 per thousand.

It is pointed out that the ratio of gas casualties undoubtedly would have been greater had the Germans been able to muster large supplies for use during the Meuse-Argonne offensive.

Gas, according to the Surgeon-General's report, accounts for 18 per cent of the time lost by casuals in the hospitals. Of those who were gassed and recovered, less than three per thousand were discharged on account of disability.

Spring Meeting, American Electrochemical Society

Plans have already been made for the spring meeting of the American Electrochemical Society, which is to be held at the Hotel Chalfonte, Atlantic City, April 21 to 23, 1921. A special symposium on corrosion will occupy the morning and afternoon programs of one day and will bring our information on this subject up to date. For another session it is planned to hold a symposium on electrolytic production of organic chemicals. Social features of the meeting will include a smoker and lecture on one evening and some moving pictures of appropriate electrochemical subjects, followed by a dance, on another evening. Dr. Carl Hering, Philadelphia, is chairman of the committee on arrangements.

Secure C.W.S. Commissions

The following have been found eligible to receive commissions as First Lieutenants in the Chemical Warfare Service: John H. Becque, Plasterco, Va.; Crawford M. Kellogg, Salt Lake City; C. E. Palmer, Newark, N. J.; E. G. Steis, South Bend, Ind.; F. J. Swanson, Fort Worth, Tex.; A. H. Waitt, Medford, Mass.

R. Carson Smith of Akron, Ohio, and Hugh A. Stewart of Brooklyn, N. Y., were found eligible as Second Lieutenants.

Chicago Section, American Ceramic Society

The annual meeting of the Chicago Section of the American Ceramic Society was held at the City Club on the afternoon of Nov. 27. The business session was called directly after the luncheon and the following officers were elected for the coming year: B. S. Radcliff, chairman; F. L. Steinhoff, vice-chairman; W. W. Wilkins, secretary-treasurer; C. W. Parmelee, councillor; H. E. Davis, chairman program committee; E. A. Brockman, chairman membership committee.

C. G. Armstrong delivered a paper on "Porcelain Enameling Furnaces." He traced the art of enameling from the time of Rameses III, about 1300 B.C., to the practice of modern times. The enameling of iron in the United States began with the establishment of a plant in Connecticut in 1863. Present-day furnaces may be classified under two groups as to the muffle type—namely, the semi-muffle and full muffle type—and several classes as to method of firing, as coal-fired, producer-fired, semi-producer, recuperative, oil-fired and gas-fired.

Comparisons were made between these types and the new design worked out by the author in which carborundum refractories embodying the regenerative features showed high efficiency for the latter. The paper will be printed in full in a later issue of CHEMICAL & METALLURGICAL ENGINEERING.

W. W. Wilkins, of the International Harvester Co., reviewed some notes on "Spark Plug Porcelain," presenting data to prove that 75 per cent of failures of spark plugs used in internal combustion engines of all types are due to faulty mechanical design, leaving only 25 per cent of failures attributable to failure of the refractory material. Tests have shown that zirconium refractories give remarkable performance.

R. Rodehouse described his oil-gas furnace for burning enameled ware. The burners operate with any sort of heavy oil atomized and mixed with air and steam. The control of temperature is absolute, with fool-proof devices to operate. The furnace has no muffles, employs no special shapes in construction, and has remarkably long life.

Oil consumption was said to be under 12 gal. of fuel per hour.

No Official Action by Electrochemical Society on Duty-Free Importations

The November *Bulletin* of the American Electrochemical Society contained an item urging friends of educational institutions to protest against the passage of the so-called Bacharach bill repealing the privilege heretofore given colleges and universities of importing scientific apparatus duty free. Official announcement has since been made by W. S. Landis, president of the American Electrochemical Society, to the effect that the item in the *Bulletin* did not represent official society opinion. He states that this matter has not received attention from either the board of directors or the membership.

Helium Discussed at the 113th Meeting of the Rochester Section, A.C.S.

At East High School on the evening of Nov. 23 Dr. Richard B. Moore lectured at the 113th meeting of the Rochester Section of the American Chemical Society, and its guests, the Science Section of the New York State Teachers' Association, on "Helium, Its Preparation and Uses."

After giving a brief history of its discovery, Dr. Moore said that helium, like the other rare gases, was found to be inert. It had no particular use and so was of no importance, except to the scientist. But in 1915 Sir William Ramsey, then with the British War Department, wrote to Dr. Moore, saying he thought there was a great possibility of helium being used in observation balloons in place of hydrogen, providing a cheap source of it could be found.

After this country entered the war, acting upon Sir William Ramsey's suggestion, the Bureau of Mines, of which Dr. Moore is chief chemist, began to study the possibilities of helium for balloons. The natural gases in Texas, Oklahoma, Washington, Kentucky and other parts of this country contain from two-tenths to five-tenths per cent of helium and the Bureau of Mines established plants in Texas, the one at Fort Worth costing about $2,000,000. The first shipment of helium was on its way to France when the armistice was signed. The plants in Texas are still in operation, for the army and navy recognize the great importance of this element. In the helium dirigible the engine can be put under or even inside, thereby getting a more direct drive and greater efficiency. When one considers that a large dirigible balloon costs about $3,000,000, the discovery of a lifting gas that will not burn is of great importance. Dr. Moore illustrated his lecture with slides of the Texas plants. He also filled a small balloon with some helium, then held a match under it, showing the helium would not burn, as hydrogen does.

Short Course in Boxing and Crating of Materials to Be Given at Forest Products Laboratory

The Forest Products Laboratory at Madison, Wis., will give three courses in boxing and crating for representatives of manufacturing concerns beginning the first of the year. The object of these courses is to demonstrate to the manufacturers and packers the principles that underlie proper box and crate construction and develop economical containers that will deliver the contents to destination in a satisfactory condition and at minimum cost. The work will include drop tests to demonstrate characteristic failures of different kinds of boxes, drum tests to demonstrate the necessity of adequate nailing, relative holding power of different kinds of nails, methods of application and efficiency of steel strapping and the use of solid and corrugated fiber board and wire-bound boxes and crates. The dates for the next three courses are Jan. 10 to Jan. 15, March 7 to March 12, and May 2 to May 7. A co-operative fee of $100 payable to the Forest Products Laboratory is charged to partly cover the cost of conducting the work. This fee does not include traveling and living expenses.

Needs a Ceramic Engineer

The Bureau of Mines is looking for a ceramic engineer to add to its staff at its ceramic experiment station at Columbus, Ohio.

General Fries Submits Annual Report

In concluding his annual report to Congress, General Amos A. Fries, head of the Chemical Warfare Service, made the following observations:

> Just as every great earthquake is followed by a large number of lesser disturbances just so the World War has been followed by a host of minor upheavals, some of considerable importance and others just reflecting the general unrest caused by the overthrow of so many governments and other establishments of law and order. These disturbances during the past year have helped crystallize sentiment and force the sober-thinking man to conclude that wars are not yet past, much as he may long to see the arrival of that day in the world's progress.
>
> The World War demonstrated that an enemy bent on aggression cannot be trusted to live up to any set rules of war. Methods of warfare develop just as all peaceful pursuits develop and they will continue to do so until such time as the nature of mankind as a whole has so changed that wars can be relegated to the past.
>
> The United States has wisely decided to continue the Chemical Warfare Service with sufficient powers and with sufficient funds to develop its possibilities, not for aggression in any way whatsoever, but to insure that if American boys must ever again shoulder arms in defense of the liberties of their country they will do so on an equal footing with any other nation so far as chemical warfare is concerned.
>
> The American is truly a sportsman and in war, as in sport, he is perfectly willing to stand any punishment providing he has an opportunity to give as well as take. The really serious objections to chemical warfare in the World War arose from the fact that the Central Empires, as well as most other countries, except the United States, had agreed not to use it. Under such circumstances a real sportsman who lives up to his agreement suffers a terrific handicap. No such handicap can occur in the future with the Chemical Warfare Service thoroughly alert to the possibilities of that arm and given power to prosecute its researches, its development and its training to the point where it knows that it is impossible for any other nation to have gone further. The knowledge among other countries that the United States is doing this will go a long way toward deterring them from forcing hostilities, knowing that the United States with its incomparable natural resources and highly developed manufacturing possibilities will be able to manufacture and to deliver on the field of battle a greater quantity of chemicals than any other single nation can manufacture and deliver, or indeed any other group of nations.

Louisiana Section, American Chemical Society

The regular monthly meeting of the Louisiana Section, American Chemical Society, was held at the Louisiana Museum, New Orleans, Tuesday evening, Nov. 16. The principal address was delivered by Dr. W. A. Noyes, who spoke on scientific research and the true nature of university work. He emphasized the value of research work in the higher institutions of learning in its application to the problems of the chemical industry as a whole for the benefit of all concerned, in contrast to the research work carried on in the individual industry for its own selfish ends.

The October meeting, the first of the season, was addressed by Dr. L. Lavedan, chief chemist, Hiller Vinegar Co., who spoke on "The Manufacture of Vinegar."

He pointed out the necessity of close chemical control to obtain efficiency in the production of vinegar. The percentage efficiency of acetic fermentation varies widely from plant to plant and operator to operator. The Southern climate is almost ideal for the work of acetic ferment. This ferment, or germ, must be nursed with great care if good service is expected. It must have regular meals of good quality. Sudden temperature changes are most harmful to production.

Conference on Colorado Clay

The Denver Civic and Commercial Association is convinced that full advantage is not being taken of the clay resources of Colorado. At the request of that organization, Dr. R. B. Moore, chief chemist of the Bureau of Mines, has arranged for a discussion of the situation in Washington. The meeting will be attended by Homer Vanderblue, the research director of the Denver organization; Dr. Moore; L. I. Shaw, assistant chief chemist; and R. T. Stull, superintendent of the bureau's ceramic station at Columbus, Ohio.

French Hydro-Electric Plant Completed

A large hydro-electric plant of 20,000 hp. has recently been completed by the Société Hydro-Electric of Lyon, a branch of the Compagnie du Gaz, Lyon, and the Compagnie Continentale Edison of Paris. The plant is located at Seyssel, Haute-Savoie, France. Importance is attached to the completion of this project because of the present scarcity and high price of coal, and likewise because of the effect it may have toward encouraging similar undertakings in France.

The plant is equipped with four turbines, each capable of developing a force of 5,500 hp. It is proposed to install another turbine at an early date, and thus increase the production to 27,000 hp., an amount that equals almost one-third of all the energy consumed under different forms by the city of Lyon.

Proposed Bill for an Association of Nitrate Producers of Chile

A cablegram from Ambassador Shea, Santiago, Chile, states that a bill has been presented to Congress by the Nitrate Commission of the Chilean Congress, to be discussed soon, for the creation of an association of nitrate producers of Chile. The bill provides for the control of freights and the purchase of ships, the purchase of materials for producers, and sales through direct agents. In addition it fixes prices and production, provides for technical work, direction of labor conditions, with a board of directors composed of eighteen men, six of whom will be appointed by the President. The government and members will contribute 10c. per 100 lb. produced until a capital of £5,000,000 is formed; the members must own an actively producing plant and not be purchasers from other producers. An export duty of 6.76 pesos gold (1 peso = 36½c. United States currency) is fixed for every 100 kilos of nitrate exported; this is to be reduced one-half for members of the association.

Industrial Situation in Holyoke

In common with other parts of the country, the industries in Holyoke, Mass., have been affected by the recent business slump. The textile mills in the city have been forced to shut down part of the time and are now running only three or four days a week.

The paper industry has also been hard hit, particularly the fine-paper mills. Many of the mills have departments down for part of each week, while others have not been operating for some time. The coarse-paper market has not yet been influenced perceptibly by the present business conditions, but there are indications that it will soon feel the effects of these conditions, as the unfilled orders of some of the mills have decreased during the past month. The dull time of the year, which includes the holiday season and inventory time, is close at hand, and the manufacturers do not see any prospect of betterment before the new year.

Many consumers of paper are not buying now, hoping that prices will go down. They have not large stocks ahead, and are buying only to such an amount as they find absolutely necessary. No great changes in prices need be expected at present in the high-grade writing papers, as raw materials and wages are still high. New rags, which are used in the highest grade writings, will probably remain at their present prices or may go higher, due to the fact that few of the textile mills in New England are producing any cuttings.

Although manufacturing conditions are unsatisfactory, there is as yet little unemployment. The manufacturers are trying to keep their organizations intact by having their mills running part time. There will probably be enough work to prevent any hardships to the employees this winter. There has been no talk of a reduction in wages, and there is no likelihood of any for some time.

Water, fuel and transportation conditions are satisfactory. The mills have enough coal for the coming winter, and unless unforeseen circumstances arise will get through fairly well.

Sherwin-Williams Co. Optimistic About Paint Industry

The sales of Sherwin-Williams Co. for the fiscal year ended Aug. 31 show a total of $75,952,000, which is a gain of $22,000,000 over the banner year of 1919. Comparison of the sales of $51,817,000 for the American companies alone with the $36,992,000 of the previous year shows a gain of 40 per cent.

According to the balance sheet the company has current assets of $27,679,859 compared with current liabilities of $6,636,738. It has $992,855 in the cash account, and inventory of $15,814,260. During the year a stock dividend of 50 per cent was declared so that the surplus account shows $4,481,667 this year compared with $7,175,311 a year ago.

Commenting upon business conditions, Walter H. Cottingham, president of the company, says:

> We see no reason why there should be any immediate let-down in the sale of paints and varnishes where the unsatisfied demand is still great. There is an immense amount of left-over repainting to be done, and with the big building boom which is bound to come, we are looking forward to continued sales gains. In fact the figures since the start of the new year, Sept. 1, show constant increases over the figures of last year.
>
> We know of no better barometer for business conditions than to study the operations of our own ten districts, twenty-seven divisions and seventy-five warehouses and distributing points, practically all of which report continued sales increases.
>
> Merchants, it is true, have a tendency to order smaller stocks, but the wise merchants are not allowing their business to run down at the heels for lack of stock. They are not letting possible declines, which might amount to a few hundred dollars in their purchases, stand in their way of making several thousand dollars profit by having good stocks on hand to keep up a permanent business and give service to their customers.
>
> In our own retail stores for the year just closed we showed a gain of 65 per cent, and since the new year started Sept. 1 there is an increase of 20 per cent over the record figures for the same period last year. This indicates an active consumer demand.
>
> A group of our managers who recently toured the country report that in all sections they visited, with a few exceptions, they heard and saw only evidences of basic soundness and prosperity. This goes back to agricultural conditions in the last analysis.

Personal

Lieutenant Colonel WALTER C. BAKER has been transferred from the Coast Artillery to the Chemical Warfare Service and has been placed in charge of the supply division in the office of the Chief of the Chemical Warfare Service.

Lieutenant Colonel CLAUDE E. BRIGHAM has been transferred from the Coast Artillery to the Chemical Warfare Service and has been placed in charge of the administrative and personnel divisions of the Service.

WILLIAM W. COBLENTZ, physicist of the Bureau of Standards, Washington, D. C., has been awarded the Janssen Medal by the French Academy of Sciences.

FRITZ J. FRANK, vice-president of the Iron Age Publishing Co., has been elected president of that company, following the resignation of William H. Taylor, who had been president and general manager for more than ten years. Mr. Taylor has resigned because of ill health, and has retired from active connection with the Iron Age Publishing Co. He went to *Iron Age* as general manager, after a group of publishers had acquired the ownership from David Williams. Previously, Mr. Taylor had been connected with various trade and engineering publications over a period of fifteen years, having for a time been vice-president of the McGraw Publishing Co. and later president of the Taylor Publishing Co. of Chicago, which consolidated *Engineer* and *Steam Engineering*. He and his associates on acquiring *Iron Age* separated what had long been a hardware department of that journal, and established it as *Hardware Age*. Mr. Frank has been with the Iron Age Publishing Co. since 1910, after an active association with other trade publications, among them *Colliery Engineer* and *Mining and Scientific Press*. He has a wide acquaintance in the iron and steel and machinery trades, is experienced in business journalism, and is thoroughly committed to the traditions and standards of *Iron Age*, which belongs in that progressive group of business publications which put editorial service to the reader as the basis for substantial and sound publishing development.

G. K. HERZOG has recently been transferred from the research department of the Electro Metallurgical Co., Niagara Falls, N. Y., to the Haynes Stellite Co., Kokomo, Ind., in charge of the research and development department.

A. STUART KELSEY is now assistant research chemist with the Standard Textile Products Co. The present investigation is at the Buchanan, N. Y., factory.

DEXTER S. KIMBALL, professor of industrial engineering at Cornell University, Ithaca, N. Y., spoke before the Detroit Engineering Society on Dec. 3 on "A Broader Field for the Engineer."

Dr. SAMUEL A. MAHOOD, formerly senior research chemist of the Forest Products Laboratory, Madison, Wis., is now associate professor of organic chemistry, Tulane University, New Orleans, La.

CHARLES A. MUNROE, vice-president of the People's Gas Light & Coke Co. of Chicago, has been elected president of the American Gas Association.

C. G. SELDEN and C. E. ANDREWS of the Walker Chemical Co., Pittsburgh, Pa., have recently sailed for England and the Continent on business for the company.

Dr. GERALD L. WENDT, of Chicago University, has just returned from a Western trip. He spoke before the Tri-City Chemists' Club at Davenport, Iowa; the Kansas City, Neb., Omaha and Ames Sections of the American Chemical Society on "Electrometric Titration." At the University of Nebraska and Grinnell College, he delivered lectures on "Activation and Elementary Gases" and the "Nature of the Atom."

Book Reviews

WHAT'S ON THE WORKER'S MIND. By *Whiting Williams*, personnel director Hydraulic Pressed Steel Co. 329 pp., illustrated. New York: Charles Scribner's Sons. Price $2.50.

Whiting Williams was not the ordinary kind of personnel director. He wished to get a first-hand impression of the man in overalls for the general good in solving the problems of capital and labor. Having arranged for his salary as personnel director to go to his family, he went forth with $25 to earn his living as a common laborer for seven months. The observations from his experiences have been set down in this interesting book. Mr. Williams' previous experience of life had been as assistant to the president of Oberlin College and as executive secretary for the Cleveland Welfare Federation.

This alert-looking young American got into a sheepskin overcoat and let his face go unshaved until he looked the part. During seven months in 1919 he worked in steel mills, coal mines, railroad yards, iron mines and shipyards. As soon as he had walked the plank of "the good ship 'White Collar,'" he found himself in a different world. He learned the feelings of men herded outside the hiring gates at the mercy of bullying guards, and of the irritating inadequacy with which many firms deal with their employees. At one large steel plant where 10,000 men are employed, "the young clerks supposed to do the hiring gave most of their time to tickling the backs of the necks or the much-exposed chests of the young stenographers," while the applicants, to whom jobs and proper consideration meant a great deal, could talk to the clerks only through two misplaced holes in plate-glass.

In all the jobs where he worked the author found much waste and inefficiency resulting from the bad influence of the wrong kind of bosses. So many corporations have elevated the wrong type of individual over his fellows that bitterness and enmity have driven out co-operation. Leaders instead of drivers are needed for foremen, the author makes plain, and chronic fatigue does not pay, as efficiency engineers have agreed since Taylor conducted his famous experiments in loading pig iron. The average unskilled worker is lacking in enthusiasm for his work, because he does not understand what it all means, and generally no inspiration is to be obtained from the foreman.

Strange to say, higher wages are not the solution of labor unrest, declares Mr. Williams. "What makes the wheels of all of us go 'round is the desire for a satisfying sense of our own individual worth-while-ness, and the cause of practically all the friction between people, and especially between people of different groups and statuses, is to be found in offended or obstructed self-respect, injured pride and hurt feelings." This is a lesson that employers are extremely slow at learning; the truth has been pointed out again and again, yet even so well-stated an argument as Mr. Williams' will probably be heeded by only a few. He continues, "We give to the dollar altogether too great an importance when we consider it the cause either of men's industry or their intrigue, their virtues or their vices. The dollar is merely an especially convenient and simple means for facilitating the measurement of a man's distance from the cipher and insignificance among his fellows. If it does not serve that end it is not sought beyond the narrow limits required for the daily bread—as where conspicuous leisure proves more valuable to this end and so causes loafing in exactly the same way that the standing which the dollar can buy for the employer brings him down diligently on time every day to his desk. Beyond a certain point, dependent upon the standing and status which the dollar can buy in the community, the increase of wages is thus quite as likely to lessen as to increase effort." Incidentally, much the same kind of argument has been advanced by the present reviewer during the past several years in articles

in *Engineering News-Record, Mining and Scientific Press,* and *Engineering and Contracting.*

Mr. Williams emphasizes the great good to the community accruing from the worker's self-respect, the self-respect that keeps "the millwright at his bench every working day, an upright, forward-looking and sincere worker and citizen." When workers lose their self-respect, says the author, from mistreatment under grouchy foremen, or from having to stand at hiring gates, or from being herded out of their rights by pompous officials, there is a certain paralyzing effect which destroys the morale of a significant part of the industrial community.

In the last several chapters of the book Mr. Williams makes some definite suggestions for bettering conditions in industry. He is opposed to the twelve-hour day and seven-day week which prevail in much of the iron and steel industry, because chronic tiredness and temper do not pay. The worker should have more security of steady work, and should not be hired and fired as a commodity to which nothing else is due—a point which Samuel Gompers has long emphasized. The so-called "Americanization," which is so glibly prated about, should be taught not only by English classes and welfare officials, but by actual demonstration of what Americanization means, as when a foreman commands, a judge instructs, a newspaper reports and a salesman sells. In other words, the officials elevated to positions of importance in our communities should be picked more carefully for their influence in illustrating the best ideals of America.

The final picture of the worker that Mr. Williams gives is that of a human being neither lazy nor avaricious, but willing to co-operate if he can understand the work and will be rewarded fairly for giving the best that he has in him. The worker is much like the rest of us, in fact, though with much less chance to learn what he wants to know about things. On the other hand he "can see fine points in a dull and monotonous job with an eye that should shame us," and he has a naïve wish to be useful and to be recognized as useful. Such considerations as these should be given sincere thought by employers. The problem of capital and labor is assuming menacing proportions. If arguments such as Mr. Williams' are not heeded, dire disaster may come to American industry. Employers should use more imagination and prescience than has been the custom among their kind. More men like Whiting Williams should be promoted to the critical positions in industry.

P. B. McDONALD.

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GAS AND FUEL ANALYSIS. By *Alfred H. White,* professor of chemical engineering, University of Michigan, Ann Arbor. International Chemical Series; second editon, revised and enlarged. Pp. xiii + 304; 54 figures. New York and London: McGraw-Hill Book Co., Inc., 1920. Price, $3.

The author of this book undertook an exceedingly difficult task when attempting to combine the functions of a text book with those of a reference volume. His purpose to this end is stated in the preface of this second edition as follows: "The needs of students have been kept in mind, but the intention has also been to make the book one which would supply the practicing engineer and chemist with the most necessary information." Despite the difficulty involved, the work succeeds admirably in presenting for student use as well as for experienced workers the important types of gas- and fuel-testing equipment and the methods for their successful use.

The second edition profits greatly by the extended additions which have been made from recent work by the Bureau of Mines, Bureau of Standards and several technical societies, notably the American Chemical Society and the American Society for Testing Materials. In most instances the methods described are the latest and best which have found general practical acceptance. In only a few cases have novel methods not yet generally used been permitted to displace or overshadow the better recognized procedures. It is evident that the author has carefully kept in mind the fact that one who will use the book will want a description of methods and equipment generally available and acceptable, rather than more novel procedures not yet accepted or for which apparatus is not usually available.

If a more frequent and elaborate attention to interpretation of analyses had been possible, this would add materially to the value of the text, both for the student and the practical worker. Because of the very general application of the work, however, such discussion of interpretation of results would have been difficult and possibly at times misleading. The author may, therefore, be excused for this omission.

It is a little unfortunate that the treatment of absorption methods for gas analysis is so limited. In this particular chapter many of the most valuable chemical procedures are mentioned, but there is no presentation of the more valuable recent types of apparatus for use in this field. The single illustration of this chapter presents an old-style Hempel outfit of a type showing evidence of such assembly as might be expected from the undergraduate student in college. The idea all too generally held that the Hempel apparatus is superior in accuracy to equipment of the Orsat type, using numerous modern styles of pipette, should not receive this encouragement. This fallacy is still further encouraged by the presentation of the Orsat apparatus in two modifications, both old and out of date, in the chapter on technical gas analysis, whereas in the chapter on exact gas analysis there is no hint by illustration as to the form of pipette which is recommended. This lack will perhaps be offset in any course of instruction by proper aid from the lectures and laboratory advisers; but for use of the practical man outside the college there is nothing to suggest that exact gas analysis is made as much more difficult by improper selection of pipette as by inferior burette or improper technique.

Successful gas and fuel analysis is chemically and physically of extreme theoretical simplicity. Success demands care and skill rather than much knowledge. The apparatus and its manipulation demand more finished technique on the part of the operator than almost any other type of chemical analysis commonly used. The opportunity for error on chemical grounds is almost *nil* by comparison. If one recognizes these points as a result either of experience or careful instruction, he can well take this text as a most valuable guide for his work. If he does not take it, it would be difficult to say what else could be recommended as a substitute in American literature.

R. S. McBRIDE.

* * *

KAOLIN OF INDIANA. By *W. N. Logan,* State Geologist of Indiana. 132 pp., cloth; 43 illustrations and colored plates. Indianapolis: The Department of Conservation, State of Indiana, Division of Geology.

This report is devoted to the geological conditions of the occurrence, the origin, geographical distribution, the physical and chemical properties and the uses of kaolin in the state of Indiana. The occurrence of large beds of kaolin in southern Indiana has long been known. Its extremely pure and crystalline appearance, together with its interstratification with sedimentary rocks, has been the cause of a great deal of speculation concerning its origin and geological occurrence. Some have suggested that a coal bed at one time occupied this horizon and was burned out, while others see in this unusual deposit the residue of a decomposed limestone. A new theory of origin is proposed in the report.

Although this clay has been used intermittently for several years, it was left for the author to make a detailed survey of the deposits and work out its origin. Extensive laboratory tests have been made of the chemical and physical properties of the clay. Samples have been tested in a large number of laboratories connected with industrial plants and Government bureaus. Topographical and geological maps of the areas in which the kaolin is found are embodied in the book.

The matter is well presented and holds much of interest to ceramists and clayworkers.

CHESTER H. JONES.

NEW INDUSTRIAL UNREST. By *Ray Stannard Baker.* 232 pp. New York: Doubleday, Page & Co.; 1920. Price, $2.

So much of the literature on industrial unrest has been written by interested parties that a discussion by a trained writer cannot fail to have an interest and a value of its own. It is difficult, however, for anyone to write on such a subject without being guided, to some extent at least, by personal opinions, and to many it will appear that Mr. Baker writes from the viewpoint of a sympathizer with organized labor rather than an impartial observer. The first twelve chapters of the book are more in the nature of a description and an interpretation of recent events in the industrial world of America. The six concluding chapters are largely devoted to a discussion of the shop-council system and its application both in Europe and in America. In this the author is developing a line of thought that is not particularly popular in our industrial world today, since, except in certain specific industries, shop councils are not in favor in America with employers or, more especially, with employees. The author recognizes the difficulty of indicating any simple solution of a problem of such complexity and appears at his best in his concluding paragraph, in which he says:

"In another sense, there is a solution. It consists in the attitude, the spirit, which one maintains toward the labor problem—an adventurous, inquiring, experimental attitude, ever hospitable toward new facts; and a generous and democratic spirit. I wonder if men can find this solution in its completeness without some high faith in God, and some vital interest in their fellow men." T. T. READ.

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THE MANUFACTURE OF SULPHURIC ACID IN THE UNITED STATES. By *A. E. Wells* and *D. E. Fogg.* 216 pp., 36 figures and 15 plates. Washington: Superintendent of Documents.

This bulletin, No. 184, is a fine report on the investigation of the sulphuric acid industry by the Bureau of Mines. It will be gladly received by the men in the industry, especially by those who have not had the opportunity of making many observations due to limitations in their outside connections. Sulphur, pyrite and pyrrhotite and byproduct sources of SO_2 are treated in an adequate manner. Production methods and equipment for the chamber and contact processes are described in fifty pages each. A remittance of 40c. is asked to help defray the costs of the distributing office.

WALLACE SAVAGE.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Dec. 6, 1920.

It could hardly be said that the general trend of affairs changed materially in the chemical market during the past week. As a whole trading was along quiet lines with the tone fairly steady. Continued absence of forced selling, however, is establishing a better feeling, while stronger confidence is gaining in business prospects for 1921. Miscellaneous buying inquiries for domestic and export needs were reported for *bichromate of soda* and these have strengthened the spot market and nearby positions to a perceptible degree. Sales for material ex store reached 9¾c. per lb., while January shipments were quoted firm by dealers at 10¼c. per lb. Leading producers named 15c. per lb. for contracts over 1921, and this price also held good for export. Resale lots for *aluminum sulphate* were offered at 3¾c. per lb. for the iron-free grade, while rumors were current that a price of 3¼c. per lb. could be had on firm business. Moderate quantities of the commercial type were quoted at 2¾c. per lb. Small lot trading of *oxalic acid* was reported at 18c. per lb., with sellers asking up to 19c. per lb. The demand is very slow and buyers show little interest in quantities exceeding actual wants. *Formaldehyde* inquiries for domestic and export requirements reached the market in more volume than any chemical on the list. Odd lots were reported to have sold at 18¾c. per lb. early in the week, with a pronounced strengthening during the latter half. At the close the market appeared quite steady at 19c. per lb. Jobbers are holding standard brands of solid *caustic soda* at $3.75@$4 per 100 lb., and reported scattered transactions at these figures. The movement in this chemical has been along quiet lines of late and the tendency to bring buyers into the market was noticed when dealers quoted figures as low as $3.65 per 100 lb. Manufacturers' views on contracts remain unchanged at 3¾c. per lb. basis 60 per cent f.o.b. works for 1921 shipment. Producers continue to name 18c. per lb. works for prime American *chlorate of potash*, while large resale lots of imported and domestic material are being offered freely at various prices down to 13c. per lb. with no actual trading noted.

COAL-TAR PRODUCTS

Prominent factors in the crude and intermediate markets are viewing conditions with more optimism. The volume of cheap resale material seemed to be diminishing in one quarter and another and some producers are expecting to name contract prices over next year in a very short time. The general feeling seems to be that considering the cost of production, the nearness of present prices to those of the pre-war period and the heavy demand that will be noted when normal conditions appear will automatically prevent any lower range, but will show good prospects of advances in a majority of commodities. Trading during the past week was of the quiet routine nature that has followed along the same lines for the past month, with buyers exhibiting timidity in most directions. The crude market is uncertain. Some items are holding steady, while others are in little demand and reflecting an easy tendency as to price. *Benzene*, c.p., is moving in fair volume with drums held at 35c. per gal. The 90 per cent is offered at 32@33c. per gal. *Naphthalene* producers have named 9@10c. per lb. for contracts over 1921. Consumers did not come into the market with this announcement, although a more stable condition is looked for in the near future. Inquiries for *alpha naphthol* are attracting attention lately and the few factors making it report the supply very limited, with the crude grade held at $1.10 per lb. and the refined at $1.45 per lb. On account of the general quiet conditions throughout all the markets and the extra receipts of *anthracene* from abroad, the supply of this product has been much easier of late and buyers have been able to force holders to make considerable concessions in some quarters. The 80 per cent grade ranged from 85c. to $1 per lb. Domestic demand for *alpha naphthylamine* remained quiet, while resale lots were not being offered as freely and producers continued to quote 47@50c. per lb. A quiet routine business is being noted in *Dinitrotoluene* in smaller lots and prices held steady at 27@30c. per lb. in the absence of any low-priced resale stocks. There is a very quiet market reported in *orthotoluidine*, with consumers taking only limited quantities to cover present needs. Prices are quoted unchanged at 30@32c. per lb.

Chemical Outlook for 1921

The chemical and allied markets have reflected flashes of activity lately, and those eager to take an optimistic view of these demonstrations believe that the long period of liquidation with all its depressing influences is nearing its end. Producers do not expect any active resumption of business similar to that of the early months of 1920, but feel confident that the new year will bring with it a vast improvement in the industrial conditions of the country. The first quarter of 1921 is looked forward to furnish the change, but a conservative, steady expansion in general business circles is expected prior to that time. The probability of easier money rates and loans from leading financial institutions is a probable factor in the business situation. Captains of finance have expressed their intentions of relieving any intense situation that may arise, and are ready with plenty of available funds. This will undoubtedly allow the launching of new enterprises and the elaboration of plans

which were formulated some time ago by leading chemical manufacturers. It stands to reason that heavy liquidation in securities and in practically every important commodity in the country has released a large supply of funds which bankers will be eager to place as soon as yearly dividends and settlements are completed.

Credits to Foreign Buyers

America is also confident that ways and means will shortly be established for the granting of extended credits to foreign buyers. This would relieve the tight situation confronting our present export trade and foster new foreign buying. While this might temporarily work against exchange rates, it is absolutely essential that European countries be allowed to purchase raw products here, as their supply is so small that it is retarding greatly their progress in a return to normal trade. Prominent chemical producers have frequently expressed their belief that Europe is sorely in need of raw materials of all kinds.

Labor Conditions

Labor conditions are still abnormal. Organized labor has undermined unionism by its drastic demands for continuous increases. Tanneries, soap factories, textile mills and dye plants have been compelled to close their doors at various times because the decline in price of finished products was not reciprocated by labor. The result is that labor will be enrolled at a price more commensurate with the cost of finished commodities when these plants resume operation. It is already significant that labor is entertaining a more conciliatory view, and as the cost of living comes down a more equitable understanding will prevail.

No Reason for Pessimism

Americans are not inclined to pessimism. A country with over 100,000,000 persons to be clothed, fed and housed will not find conditions stagnant for an indefinite period. Depression has featured the chemical industry since last May. Although large losses have been taken, there are still a few more to be assumed. The sooner this is realized the better; but the dark streaks are gradually dwindling away and American industry is coming into its own before long primed for its battle of world-wide trade supremacy.

The Baltimore Market

Baltimore, Dec. 4, 1920.

Little change can be reported in the local market on fertilizer raw materials. Baltimore fertilizer manufacturers depend largely on the Southern territory as an outlet for their goods. Because of the sudden break in the price of cotton, Southern planters are generally in a bad financial condition, and as a consequence the manufacturers are having little success in collecting for goods shipped during the past season. As a direct result of this tight money situation in the fertilizer industry, comparatively small tonnages of raw materials are being purchased and the purchases that are being made are strictly on a hand-to-mouth basis. At this time it would appear that the tonnage of fertilizer used in the South will be greatly curtailed.

We may sum up the situation by saying we have a waiting market with good stocks of material in evidence and no particular interest being shown in them.

Acid Phosphate.—The market may be quoted nominal at $16.50 per ton, basis 16 per cent bulk, run-of-pile. Round tonnages to fertilizer dry mixers could be closed as low as $16 on this basis.

Nitrate of Soda.—Importers are quoting the market nominal at $2.90 per 100 lb. ex vessel Atlantic ports. Resale lots of round tonnages, however, have been recorded as low as $2.75. The market on nitrate at this time is quite uncertain and the trend seems to be downward.

Sulphate of Ammonia.—Resale lots have been offered this week as low as $4 per 100 lb., basis 25 per cent, in single or double bags f.o.b. shipping point. Large stocks are not in evidence at this time.

Potash.—A number of resale parcels of German and Alsation salts have been placed before our trade. We quote the market nominal, muriate $1.80 per unit, kainit and manure salts $1.75 per unit, all ex vessel North Atlantic ports. Nebraska potash is being quoted nominal at $2 per unit f.o.b. mines, in single bags.

Fish Scrap.—There has been no further change in the market on machine-dried unground menhaden fish scrap. This commodity is still being quoted and occasional sales are effected at $4 per unit of ammonia and 10c. per unit B. P. L. ex schooner, Baltimore, in buyers' bags. A good stock of unground scrap is still being held by the fish factories. This is a very unusual situation, as the scrap production is usually entirely absorbed by the end of the fishing season. We have previously reported that all the factories on the Chesapeake Bay have "cut out" for the year.

The Iron and Steel Market

Pittsburgh, Dec. 3, 1920.

The reductions in bars, shapes and plates to the Steel Corporation level made a week ago today, as noted in last report, have not induced the placing of an appreciable amount of business, nor indeed was it expected that any great amount of business would result at once. It was simply a case of the independents being clearly in an untenable position as to prices, with the incentive for maintaining prices removed, the incentive previously having been that of being able to make contract deliveries. Contracts had run out or customers were refraining from furnishing any further specifications. At this writing two or three of the Eastern independents have not yet reduced their quotations, and this may indicate that they still have some contract tonnage. As to the market, there is no range of prices, since any one of the sellers at the Steel Corporation prices could take care of the entire demand now found in the market.

Monday of this week a large independent producer of wire in the Pittsburgh district came down to the Steel Corporation prices, 3.25c. for plain wire and $3.25 for nails. Other independents have shown no haste to make formal reductions, their position being that they still have some contract business on books, while there is no important business in the market to be lost by not meeting the situation. The entire market for wire products is now quotable as follows: Wire nails, $3.25; plain wire, 3.25c.; galvanized wire, 3.95c.; painted barb wire, 3.65c.; galvanized barb wire, 4.35c. The nail price is that of the Industrial Board schedule, but the price on wire is $5 per ton above the Industrial Board figure, the American Steel & Wire Co. having made an advance of that amount last August.

Manufactured Steel Products

Adjustments are naturally to be expected in manufactured steel products, in harmony with the declines in the hot rolled material. Last Monday two producers of cold-finished steel bars formally reduced their quotations by $8 a ton, from 4c. to 3.60c., and others intimated that they would reduce their quotations whenever attractive business should be offered. On Wednesday a leading producer of bolts and nuts announced new discounts, representing reductions from prices previously prevailing of approximately 20 per cent. Rivets, spikes, chain, etc., are awaiting readjustment.

Contract Adjustments

In most cases when producers have made reductions it is either formally stated or is inferred that any unfilled business remaining on books will be adjusted to the reduced prices. This is the common practice in finished steel products. While contracts are made, the contract is largely in the nature of an option given the buyer, who by refraining from specifying can nullify the contract. Long ago a contract for three months, six months or a year was regarded practically as involving simply a lump amount, but a few years ago the mills instituted a change, whereby the contract required specifications in equal monthly quantities, and any tonnage unspecified monthly would automatically be canceled. The option feature of the arrangement is usually extended so that a mill will accept cancellation when the actual specifications have been filed, provided manufacture has not been commenced. In semi-finished steel and pig iron the sales practice is different, contracts being regarded as

absolutely binding, though as a matter of accommodation postponement of delivery is frequently permitted. Several years ago the sheet mills instituted what they denominated a great reform, a binding contract being adopted, providing for reciprocal damages, against the mill if delivery was not made and against the buyer if specifications were not furnished and the material accepted. It is doubtful, however, whether the sheet mills will seriously attempt to enforce contracts at this time.

Pipe and Sheets

In tin plate, bars, shapes, plates and wire products the independent market is now down to the Steel Corporation market, the change having occurred quickly and proving much less spectacular than might have been expected. Of the prominent rolled products rails, sheets and pipe still present two markets. In rails the Steel Corporation has not formally announced its prices, but these will doubtless be 6.20c. for galvanized sheets, these prices being $10 a ton with the Industrial Board schedule, and presumably the independents will make the same prices.

In sheets the market continues to decline rapidly, the decline in the past week being half a cent a pound or more. Several independents are now willing to take business at 4.05c. for blue annealed sheets, 4.85c. for black sheets and 6.20c. for galvanized sheets, these prices being $10 a ton above the Steel Corporation or Industrial Board prices.

In pipe, which has been by far the strongest of the finished products, the Steel Corporation and independents have been only $7 a ton apart, the Steel Corporation's prices representing a basing discount of 57½ per cent, while the list issued by the independents early in the year is on a 54 per cent basis. Independents have at times secured large delivery premiums above their regular list. The market is in such condition that the independents may not have occasion to reduce for many weeks.

Yesterday the American Sheet & Tin Plate Co. had its semi-annual opening of order books, whereby contracts will be made with manufacturing consumers for the first half of 1921, prices being the Industrial Board prices continuously maintained by the Steel Corporation: Tin plate, $7 per base box, 100 lb.; blue annealed sheets, 10 gage, 3.55c.; black sheets, 28 gage, 4.35c.; galvanized sheets, 28 gage, 5.70c. As the company will carry over about three months of work, the deliveries to be arranged on new contracts will be practically for the second quarter.

Pig Iron

Declines in pig iron have continued. Although there has been scarcely any incentive by way of inquiry, furnace quotations are down in the week by $2.50 on bessemer and $2 on foundry and basic, to $37 for foundry, $35 for bessemer and $33 for basic, f.o.b. valley furnaces, freight to Pittsburgh being $1.96. Again it is suggested by furnace interests that the remainder of the pig iron decline will be relatively slow, and doubt is even expressed whether basic iron will be down to $30 before April 1. As to the eventual bottom of the pig iron market, before an upturn occurs, practically all views lie within the limits of $25 and $30 for basic and foundry grades.

The Future

The iron and steel market generally is altogether too stagnant for the condition to last. After a period of activity the market can be entirely inactive for a time, but in a prolonged period of dullness there must be some buying from day to day. On this basis a moderate revival in demand is expected to occur immediately after Jan. 1, but no general buying movement, with any stiffening in prices, is to be expected before April at the earliest. While the decline in the independent market to the Steel Corporation level was universally expected, hardly anyone expects the independents to stop at that level, and it is probable that more or less shading will eventually develop, though perhaps not to an extent that would require the Steel Corporation to reduce its prices. Apart from the matter of prices, which is a detail the steel producers are bright enough and quick enough to take care of, no heavy demand for steel can be expected until the country has completed its readjustment and the cost of consuming steel has been reduced.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.65 – $0.75
Acetone	lb.	$0.15½–$0.16	.16½– .17
Acid, acetic, 28 per cent.	100 lbs.	3 00 – 3.25	3.50 – 3.75
Acetic, 56 per cent.	100 lbs.	7 25 – 7 50	7.75 – 8 00
Acetic, glacial, 99¼ per cent. carboys	100 lbs.	10 50 – 11 00	11.25 – 11 50
Boric, crystals	lb.	.14½– .15	.15½– .16
Boric, powder	lb.	.15½– .16½	.17 – .18
Citric	lb.	—	.50 – .52
Hydrochloric (nominal)	100 lb.	1.85 – 2.25	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 – .16	.16½– .18
Lactic, 44 per cent tech.	lb.	.10 – .11	.11½– .12
Lactic, 22 per cent tech.	lb.	.04½– .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg.	lb.	.07 – .07½	.08 – .08½
Nitric, 42 deg.	lb.	.07½– .08	.08½– .09½
Oxalic, crystals	lb.	.17 – .17½	.18 – .19
Phosphoric, Ortho, 50 per cent solution	lb.	.19 – .19½	.19½– .21
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	—	—
Sulphuric, 60 deg., drums	ton	—	14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 –19.00	—
Sulphuric, 66 deg., drums	ton	21.00 –22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23 00 – 24 00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25 00 – 26 00	26 50 – 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00–35.00	40.00 –
Tannic, U. S. P.	lb.	—	1.35 – 1.45
Tannic (tech.)	lb.	.50 – .55	.56 – .60
Tartaric, crystals	lb.	—	.46 – .49
Tungstic, per lb. of WO	lb.	—	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	—	5.50 – 6.00
Alcohol, Methyl (see methanol)			
Alcohol, denatured, 188 proof (nominal)	gal.	—	.84 – .86
Alcohol, denatured, 190 proof (nominal)	gal.	—	.88 – .90
Alum, ammonia lump	lb.	.04½– .04¾	.05 – .05½
Alum, potash lump	lb.	.05½– .06	.06½– .07
Alum, chrome lump	lb.	.13 – .13½	.14 – .14½
Aluminum sulphate, commercial	lb.	.02½– .03	.03½– .03½
Aluminum sulphate, iron free	lb.	.03½– .04	.04½– .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½– .08	.08½– .09½
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.36 – .38
Ammonium carbonate, powder	lb.	.14 – .14½	.14½– .15
Ammonium chloride, granular (white salammoniac)	lb.	.12 – .12½	.12½– .13
Ammonium chloride, granular (gray salammoniac)	lb.	.11 – .12	.12½– .13
Ammonium nitrate	lb.	— .10	.11 – .14
Ammonium sulphate	lb.	.04 – .04½	.04½– .04½
Amylacetate	gal.	—	4.50 – 5.00
Amylacetate tech.	gal.	—	4.00 – 4.20
Arsenic, oxide, lumps (white arsenic)	lb.	.12 – .12½	.12½– .13
Arsenic, sulphide, powdered (red arsenic)	lb.	.15 – .15½	.15½– .16
Barium chloride	ton	85 00 –90 00	95.00 –100 00
Barium dioxide (peroxide)	lb.	.24 – .25	.25 – .27
Barium nitrate	lb.	.12 – .12½	.13 – .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½– .05	.05½– .06
Bleaching powder (see calcium hypochlorite)		—	—
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	—
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.70 – .80	.85 – .90
Calcium acetate	100 lbs.	2.50 – 2.75	—
Calcium carbide	lb.	.04 – .04½	.04½– .05
Calcium chloride, fused, lump	ton	30.00 –32.00	33.00 – 35.00
Calcium chloride, granulated	lb.	.02 – .02½	.03 – .03¼
Calcium hypochlorite(bleaching powder)	lb.	.03½– .03¾	.04 – .04½
Calcium peroxide	lb.	—	1.50 – 1.70
Calcium phosphate, monobasic	lb.	—	.75 – .80
Calcium sulphate, pure	lb.	—	.25 – .30
Camphor	lb.	—	1.05 – 1.10
Carbon bisulphide	lb.	.08 – .08½	.09 – .09½
Carbon tetrachloride, drums	lb.	.13 – .13½	.14 – .14½
Carbonyl chloride (phosgene)	lb.	—	.60 – .75
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	—	.43 – .50
Cobalt oxide	lb.	—	3.90 – 4.00
Copperas (see iron sulphate)		—	—
Copper carbonate, green precipitate	lb.	.23 – .24	.24½– .25½
Copper cyanide	lb.	—	.65 – .70
Copper sulphate, crystals	lb.	.06½– .06½	.07 – .07½
Cream of tartar (see potassium bitartrate)		—	—
Epsom salt (see magnesium sulphate)		—	—
Ethyl Acetate Com. 85%	gal	—	1.05 – 1.10
Ethy Acetate pure (acetic ether 98% to 100%)		—	—
Formaldehyde, 40 per cent (nominal)	lb.	.18½– 18½	19 – .20
Fusel oil, ref.	gal.	—	3.60 – 3.75
Fusel oil, crude (nominal)	gal.	—	3.25 – 3.50
Glauber's salt (see sodium sulphate)		—	—
Glycerine, C. P. drums extra	lb.	—	.1 – .22
Iodine, resublimed	lb.	—	3.75 – 4.00
Iron oxide, red	lb.	—	.15 – .25
Iron sulphate (copperas)	100 lbs.	2.25 – 2.50	2.75 – 3.00
Lead acetate, normal	lb.	—	.13½– .16
Lead arsenate (paste)	lb.	.13 – .14	.14½– .15
Lead nitrate, crystals	lb.	—	.90 – 1.00
Litharge	lb.	.12 – .12½	.13 – .13½
Lithium carbonate	lb.	—	1.50 –
Magnesium carbonate, technical	lb.	.10 – .11	.11½– .12
Magnesium sulphate, U. S. P.	100 lb.	3.50 – 4.00	—
Magnesium sulphate, commercial	100 lb.	—	3.00 – 3.25
Methanol, 95%	gal.	—	1.90 – 2.00
Methanol, pure	gal.	—	2.30 – 2.35
Nickel salt, double	lb.	—	.12 – .12½
Nickel salt, single	lb.	—	.13 – .13½
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.50 – .52	.53 – .55
Phosphorus, yellow	lb.	—	.35 – .37
Potassium bichromate	lb.	.20 – .21	.21½– .22½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	..... –	$0.43 – $0.47
Potassium bromide, granular	lb.	..... –	.45 – .50
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.13 – .13½	.13½ – .14
Potassium chlorate, crystals	lb.	.13 – .14	.15 – .18
Potassium hydroxide (caustic potash)	lb.	.16 – .16½	.16½ – .17
Potassium iodide	lb.	..... –	3.00 – 3.20
Potassium nitrate	lb.	.14 – .16	.16½ – .17
Potassium permanganate	lb.	.60 – .63	.65 – .70
Potassium prussiate, red	lb.	.55 – .57	.58 – .60
Potassium prussiate, yellow	lb.	.34 – .35	.35½ – .36
Potassium sulphate (powdered)	ton	$240.00 – 255.00	..... – .....
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	52.00 – 55.00
Silver cyanide (nominal)	oz.	..... –	1.25 – .....
Silver nitrate (nominal)	oz.	..... –	.55 – .57
Soda ash, light	100 lb.	1.90 – 2.00	2.10 – 2.30
Soda ash, dense	100 lb.	2.50 – 2.75	3.00 – 3.25
Sodium acetate	lb.	.08 – .08½	.08½ – .09
Sodium bicarbonate	100 lb.	2.90 – 3.00	3.25 – 3.50
Sodium bichromate	lb.	.09½ – .09¾	.09¾ – .10
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.06½ – .07	.07½ – .08
Sodium borate (borax)	lb.	.08½ – .08¾	.09 – .09½
Sodium carbonate (sal soda)	100 lb.	1.85 – 2.00	2.15 – 2.25
Sodium chlorate	lb.	.10 – .10½	.10¾ – .11
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .28
Sodium fluoride	lb.	.17 – .17½	.17¾ – .18½
Sodium hydroxide (caustic soda)	100 lb.	3.75 – 4.00	4.25 – 4.35
Sodium hyposulphite	lb.	..... –	.04 – .04½
Sodium molybdate	lb.	2.50 –	3.25 – .....
Sodium nitrate	100 lb.	3.00 –	3.25 – .....
Sodium nitrite	lb.	.07 – .07½	.07½ – .08
Sodium peroxide, powdered	lb.	.35 – .40	.42 – .45
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04¼ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.33 – .35
Sodium prussiate, yellow	lb.	.18 – .18½	.19 – .20
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01¾	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.03 – .03½	.03½ – .04
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	2.15 – 2.50	2.60 – 2.75
Sodium sulphide, crystal, 60-62 per cent (cone)	lb.	.07 – .07½	.07½ – .08
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb.	.20 – .20½	.21 – .22
Sulphur chloride red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	..... –	3.70 – 4.35
Sulphur, roll (brimstone)	100 lb.	..... –	3.40 – 3.90
Tin bichloride, 50 per cent	lb.	.18 – .19	..... – .....
Tin oxide	lb.	..... –	.50 – .51
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.12 – .13	.13½ – .14
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13 – .14
Zinc oxide, XX	lb.	.09½ – .09¾	.10 – .10½
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 —	$1.15
Alpha-naphthol, refined	lb.	1.45 —	1.50
Alpha-naphthylamine	lb.	.47 —	.50
Aniline oil, drums extra	lb.	.26 —	.27
Aniline salts	lb.	.32 —	.33
Anthracene, 80% in drums (100 lb.)	lb.	.90 —	1.00
Benzaldehyde (f.f.c.)	lb.	2.00 —	2.10
Benzidine, base	lb.	1.15 —	1.20
Benzidine sulphate	lb.	1.10 —	1.15
Benzoic acid, U.S.P.	lb.	.80 —	.85
Benzoate of soda, U.S.P.	lb.	.80 —	.90
Benzene, pure, water-white, in drums (100 gal.)	gal.	.35 —	.40
Benzene, 90%, in drums (100 gal.)	gal.	.32 —	.33
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech.	lb.	.25 —	.35
Beta-naphthol benzoate (nominal)	lb.	3.50 —	4.00
Beta-naphthol, sublimed (nominal)	lb.	.75 —	.80
Beta-naphthol, tech (nominal)	lb.	.42 —	.45
Beta-naphthylamine, sublimed	lb.	2.25 —	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 —	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 —	1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.05 —	1.10
Cresylic acid, 50%, first quality, drums	gal.	.65 —	.75
Dichlorbenzene	lb.	.07 —	.10
Diethylaniline	lb.	1.45 —	1.50
Dimethylaniline	lb.	.75 —	.80
Dinitrobenzene	lb.	.30 —	.37
Dinitroclorbenzene	lb.	.27 —	.32
Dinitronaphthalene	lb.	.42 —	.45
Dinitrophenol	lb.	.40 —	.45
Dinitrotoluene	lb.	27 —	.30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 —	.40
Diphenylamine (nominal)	lb.	.75 —	.77
H-acid (nominal)	lb.	1.60 —	1.65
Meta-phenylenediamine	lb.	1.25 —	1.30
Monochlorbenzene	lb.	.17 —	.18
Monoethylaniline	lb.	1.75 —	2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	.09 —	.09½
Naphthalene, flake	lb.	.09 —	.09½
Naphthalene, balls	lb.	.09½ —	.10
Naphthionic acid, crude	lb.	.70 —	.75
Nitrobenzene	lb.	.12 —	.15
Nitro-naphthalene	lb.	.40 —	.50
Nitro-toluene	lb.	.18 —	.25
Ortho-amidophenol	lb.	3.20 —	3.75
Ortho-dichlor-benzene	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.75 —	.80
Ortho-nitro-toluene	lb.	.25 —	.40
Ortho-toluidine	lb.	.30 —	.32
Para-amidophenol, base	lb.	2.20 —	2.25
Para-amidophenol, HCl	lb.	2.10 —	2.15
Para-dichlorbenzene	lb.	.10 —	.15
Paranitroaniline	lb.	1.05 —	1.10
Para-nitrotoluene	lb.	1.25 —	1.40
Para-phenylenediamine	lb.	2.20 —	2.35
Para-toluidine	lb.	1.85 —	2.00
Phthalic anhydride	lb.	.60 —	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.08 —	.10
Pyridine	gal.	2.00 —	3.50
Resorcinol, technical	lb.	2.90 —	3.00
Resorcinol, pure	lb.	3.75 —	4.15
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.33 —	.35
Salicylic acid, U. S. P.	lb.	.37 —	.40
Salol	lb.	.85 —	.95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 —	.35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 —	.22
Sulphanilic acid, crude	lb.	.32 —	.35
Tolidine	lb.	1.45 —	1.50
Toluidine, mixed	lb.	.45 —	.55
Toluene, in tank cars	gal.	.35 —	.....
Toluene, in drums	gal.	.38 —	.40
Xylidines, drums, 100 gal.	lb.	.45 —	.50
Xylene, pure, in drums	gal.	.40 —	.42
Xylene, pure, in tank cars	gal.	.45 —	.....
Xylene, commercial, in drums, 100 gal.	gal.	.37 —	.38
Xylene, commercial, in tank cars	gal.	.30 —	.....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.26 —	$0.27
Beeswax, refined, light	lb.	.28 —	.30
Beeswax, white pure	lb.	.35 —	.40
Carnauba, No. 1. (nominal)	lb.	.80 —	.90
Carnauba, No. 2, Nor h Country	lb.	.37 —	.38
Carnauba, No. 3, North Country	lb.	.25 —	.26
Japan	lb.	.19 —	.20
Montan, crude	lb.	.12 —	.14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.07½ —	.08
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.07½ —	.07¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.09 —	.09¼
Paraffine waxes, refined, 125 m.p.	lb.	.09½ —	.09¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.10½ —	.11
Paraffine waxes, refined, 133-135 m.p.	lb.	.13½ —	.14½
Paraffine waxes, refined, 135-137 m.p.	lb.	.14½ —	.15½
Stearic acid, single pressed	lb.	.16½ —	.17
Stearic acid, double pressed	lb.	.17 —	.18
Stearic acid, triple pressed	lb.	.19 —	.20

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist.	gal.	1.50
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.25
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$10 50 —	.....
Rosin E-I	280 lb.	10 50 —	.....
Rosin K-N	280 lb.	10 50 —	.....
Rosin W. G.-W. W.	280 lb.	10.75 —	11.00
Wood rosin, bbl.	280 lb.	11.00 —	.....
Spirits of turpentine	gal.	.96 —	.....
Wood turpentine, steam dist.	gal.	.94 —	.....
Wood turpentine, dest. dist.	gal.	.94 —	.....
Pine tar pitch, bbl.	200 lb.	..... —	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	15.00
Retort tar, bbl.	500 lb.	15.00 —	15.50
Rosin oil, first run	gal.	.70 —	.....
Rosin oil, second run	gal.	.73 —	.....
Rosin oil, third run	gal.	.90 —	.....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine (nominal)	lb.	$0.22 —	$0.23
Upriver coarse (nominal)	lb.	.15 —	.16
Upriver caucho ball (nominal)	lb.	.16½ —	.17¼
Plantation—First latex crepe	lb.	.19 —	.....
Ribbed smoked sheets	lb.	.18 —	.....
Brown crepe, thin, clean	lb.	.16 —	.....
Amber crepe No. 1	lb.	.17 —	.....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.14½ —	$0.15
Castor oil, AA, in bbls.	lb.	.15 —	.15½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11 —	.11½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.14½ —	.15
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.15½ —	.16½
Corn oil, crude, in bbls.	lb.	.09½ —	.10
Cottonseed oil, crude (f.o.b. mill)	lb.	.06 —	.07
Cottonseed oil, summer yellow	lb.	.09½ —	.10
Cottonseed oil, winter yellow	lb.	.11 —	.12
Linseed oil, raw, car lots (domestic)	gal.	.80 —	.....
Linseed oil, raw, tank cars (domestic)	gal.	.75 —	.77
Linseed oil, boiled, car lots (domestic)	gal.	.82 —	.....

Olive oil, commercial	gal.	2.75 —	3.00
Palm, Lagos	lb.	.08 —	.09
Palm, Niger	lb.	.07½ —	.08½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08½ —	.09
Peanut oil, refined, in bbls.	lb.	.14½ —	.14½
Rapeseed oil, refined in bbls.	gal.	1.15 —	1.20
Rapeseed oil, blown, in bbls.	gal.	1.25 —	1.35
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09½ —	.10
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 —	.07½
FISH			
Light pressed Menhaden	gal.	$0.65 —	$0.70
Yellow bleached Menhaden	gal.	.67 —	.70
White bleached Menhaden	gal.	.72 —	.75
Blown Menhaden	gal.	1.05 —	1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	$30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	.....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	60.00 —	65.00
Casein	lb.	.14 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½ —	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground f.o.b. Baltimore	net ton	27.00 —	30.00
Fuller's Earth, f.o.b. New York	net ton	..... —	18.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 —	.....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00 —	.....
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.	lb.	..... —	.09
Graphite, crucible, 85% carbon, Ashland, Ala.	lb.	.07 —	.09
Graphite, higher lubricating grades	lb.	.11 —	.40
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic, lump	lb.	.06 —	.....
Pumice stone, ground	lb.	.04 —	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	1.00 —	1.05
Shellac, orange superfine	lb.	1.05 —	1.10
Shellac, A. C. garnet	lb.	.90 —	.95
Shellac, T. N.	lb.	.85 —	.95
Soapstone	ton	15.00 —	25.00
Sodium Chloride	long ton	..... —	17.50
Talc, paper-making grades, f.o.b. Vermont	ton	12.00 —	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50 —	15.00
Talc, rubber grades, f.o.b. Vermont	ton	12.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, imported	ton	60.00 —	70.00
Talc, California Talcum Powder grade	ton	20.00 —	45.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100-110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.17 —	.18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferro-manganese, 76-80% Mn, domestic	gross ton	140.00 —	145.00
Ferro-manganese, 76-80% Mn, English	gross ton	135.00 —	140.00
Spiegeleisen, 18-22% Mn	gross ton	60.00 —	65.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.00 —	2.50
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	85.00
Ferro-silicon, 75%	gross ton	..... —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.65 —	.75
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 —	7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than H4% moisture	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	65
Chrome ore, 50%, Cr_2O_3, f.o.b. Atlantic Seaboard	unit	.60 —	65
Coke, foundry, f.o.b. ovens	net ton	9.00 —	10.50
Coke, furnace, f.o.b. ovens	net ton	8.00 —	9.00
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00 —	25.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.00 —	.....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50 —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01½
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.45 —	.50
Manganese ore, chemical (MnO_2)	gross ton	65.00 —	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	35.00 —	.....
Pyrites, Spanish, fines ,c.i.f., Atlantic seaport	unit	.12 —	.....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.17 —	.....
Pyrites domestic, fines, f.o.b. mines, Ga.	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.....
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	5.00 —	.....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	4.25 —	5.00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 —	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.50 —	.....
Zircon, washed, iron free	lb.	.05 —	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	15.00
Aluminum, 98 to 99 per cent	32.00
Antimony, wholesale lots, Chinese and Japanese	6.00
Nickel, ordinary (ingot)	43.00
Nickel, electrolytic	45.00
Tin, 5-ton lots	34.50
Lead, New York, spot	6.25
Lead, E. St. Louis, spot	6.25
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	6.75

OTHER METALS

Silver (commercial)	oz.	$0.91½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.55
Cobalt	lb.	6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	75.00
Iridium	oz.	350.00@400.00
Palladium	oz.	75.00
Mercury	75 lb.	55.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	22.50
Copper bottoms	34.00
Copper rods	29.00
High brass wire and sheets	22.25
High brass rods	19.00
Low brass wire and sheets	30.50
Low brass rods	19.50
Brazed brass tubing	36.25
Brazed bronze tubing	41.50
Seamless copper tubing	26.00
Seamless high brass tubing	25.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12.00	17.00	11.00	11.50
Copper, heavy and wire	11.50	16.00	10.50	11.00
Copper, light and bottoms	10.00	14.00	9.50	10.00
Lead, heavy	5.50	4.75	5.00	5.25
Lead, tea	4.50	3.75	3.75	4.00
Brass, heavy	7.00	10.50	7.00	11.25
Brass, light	5.50	7.50	5.00	6.00
No. 1 yellow brass turnings	7.00	10.00	5.50	6.00
Zinc	4.50	5.00	3.50	4.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3.80	$4.15	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	3.70	4.15	3.37	3.34	3.27	3.48	3.37
Soft steel bar shapes	3.70	4.15	3.37	3.48	3.27	3.48	3.37
Soft steel bands	4.65	5.50	4.07	6.25	.....	.....	.....
Plates, ¼ to 1 in. thick	4.00	4.15	3.67	3.78	3.57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Continental Gin Co., 3330 10th Ave., has awarded the contract for the construction of a 1-story, 132x400-ft. foundry and a 1-story, 100x300 ft. machine shop, to the H. K. Ferguson Co., 6523 Euclid Ave., Cleveland, O. Estimated cost, $500,000.

Connecticut

BRIDGEPORT—The city has awarded the contract for furnishing and installing machinery and equipment for the proposed sewage disposal plant on Harborview Ave., Black Rock Station, to the Sanitation Co., 50 Church St., New York City. Estimated cost, $19,500.

HARTFORD—The Bd. of Water Comrs. will receive bids January 10 for furnishing 21,000 yd. of filter sand and about 12,000 yd. of filter sand for filter beds. C. M. Saville, engr.

WEST HAVEN—The Union School Dist., Orange, is having plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, between $350,000 and $400,000. R. W. Foote, 185 Church St., New Haven, archt.

Indiana

INDIANAPOLIS—The Pioneer Brass Wks., 424 South Pennsylvania St., is having plans prepared for the construction of a 1-story machine shop. J. H. Brinkmeyer, pres. C. Brossman, engr.

MICHIGAN CITY—The Steel Fabricating Co., Harvey, Ill., is building a plant here.

Iowa

SHELBY—The Bd. Educ. has awarded the contract for the construction of a 2-story, 120x190-ft. high school, to J. E. Wakefield Co., 750 Brandeis Theatre Bldg. Omaha, Neb. A chemical laboratory will be installed in same. Estimated cost, $149,900.

Maryland

AMCELLE (Baltimore P. O.) — The Amer. Cellulose & Chemical Mfg. Co. Ltd., 681 5th Ave., New York City, has awarded the contract for the construction of a 1-story plant, to the G. A. Fuller Co., 175 5th Ave., New York City. Estimated cost, $200,000.

BALTIMORE—The Metal Package Corp., Wolfe and Thames Sts., plans to construct a tinplate and lithogaphing plant.

Massachusetts

NATICK—The Griess Pfleger Tanning Co. of Massachusetts, P. O. Box 271, plans to build an addition to its leather manufacturing plant.

Michigan

DETROIT—The Anchor Bldg. Co., c/o F. J. Winter, archt., 2331 Dime Bank Bldg., is having plans prepared for the construction of a 2-story, 50x100-ft. paint shop on West Grand Blvd. Estimated cost, $50,000.

DETROIT—The Bd. Educ., 50 Bway, will receive bids until December 21 for the construction of a 5- and 7-story, 250x350 ft. technical high school on 2d Ave. and High St. A chemical laboratory will be installed in same. Estimated cost, $2,500,000. Higginbotham, Malcolmson & Palmer, 405 Moffat Bldg., archts.

DETROIT—G. W. Graves, archt., 43 John R. St., will receive bids until Dec. 10 for the construction of a 1-story, 90x200-ft. foundry for the Zenith Fdry Co., Miller Ave. Foundry equipment will be installed in same.

Minnesota

MANKATO—The Immanuel Hospital Association plans to build a 2- or 3-story addition to hospital. A chemical and pathological laboratory and an X-ray department will be installed in same. Estimated cost, $150,000.

ST. PAUL—The city has awarded the contract for 30,000 lb. of liquid chlorine for treating city water in 100-lb. cylinders, to Noyes Bros. & Cutler, 6th and Sibley Sts., at 9c. per lb. Noted Oct. 27.

New York

ITHACA—Cornell University plans to construct a 5-story, 190x268-ft. chemical building. Gibb & Waltz, Trust Co. Bldg., archts.

YONKERS—The Hudson & Rubber Corp., Proctor Bldg., has awarded the contract for the construction of a 3-story factory on Nepperhan Ave., to James Mitchell Inc., 76 Montgomery St., Jersey City, N. J. Estimated cost, $300,000.

North Dakota

JAMESTOWN—The Bd. Educ. will receive bids Jan. 1 for the construction of a 3-story, 125x195 ft. high school. A chemical laboratory will be installed in same. Estimated cost, $175,000. Shannon, Boyd & Boyd, engrs.

Ohio

CLEVELAND—The Atlas Fdry Co., 7275 Shaw Ave., has awarded the contract for the construction of a 1-story, 37x45-ft. addition to its foundry, to D. Gilchrist, Peoria. Estimated cost, $25,000. Noted Oct. 27.

MT. VERNON—The C. & G. Cooper Co., 11 Bway, New York City, has awarded the contract for the construction of a 1- and 2-story foundry and machine shop, to D. P. Robinson & Co., Inc., 125 East 46th St., New York City. Estimated cost about $400,000.

Oklahoma

BARTLESVILLE—The Bd. of Comrs. will soon receive bids for the construction of a sewage disposal plant, etc. Estimated cost, $200,000. E. D. Kirkpatrick, engr.

SAPULPA—The city is having plans prepared for the construction of a dam, reservoir, filter basins, force main, distributing reservoirs, etc. The Halway Eng. Co., 230 Lynch Bldg., engr.

Pennsylvania

LEWISTOWN—The Pennsylvania Wire Glass Co., Pennsylvania Bldg., is having plans prepared for the construction of a 1-story, 175x600-ft. glass plant. Epuipment will be installed in same. F. A. Hayes, Pennsylvania Bldg., archt.

Rhode Island

PAWTUCKET—The Berry Spring Mineral Water Co., 3 Charlton Ave., has awarded the contract for the construction of a 2-story, 40x40-ft. addition to its plant, to the C. I. Bigney Constr. Co., 357 Westminister St., Providence. Estimated cost, $15,000.

Texas

EASTLAND—The city will soon award the contract for the construction of a sewage disposal plant to include an Imhoff tank, sprinkling filter and sludge bed. J. A. Wright, city engr.

Virginia

QUANTICO—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., received bids for the construction of an incinerator plant to include a septic tank, etc., at the Marine barracks, here, from the King Lumber Co., Charlottesville, $41,800; Hyde & Baxter, 1311 G. St., N.W. Wash., D. C., $46,000; Newport Constr. & Eng. Co., Newport News $48,310. Noted Nov. 3.

West Virginia

WHEELING—The Wheeling Axle Co. has awarded the contract for the construction of a 2-story addition to its axle factory on 27th St., to J. E. Moss. Estimated cost, $6,500.

Wisconsin

GRANVILLE—The T. J. Moss Tie Co., Security Bldg., St. Louis, Mo., has awarded the contract for the construction of a 1-story, 40x200-ft. creosoting plant, etc., to J. L. Stanage, 144 Oneida St., Milwaukee. Noted Nov. 24.

MILWAUKEE—The Milwaukee Children's Hospital, 219 10th St., is having preliminary plans prepared for the construction of a hospital building, etc., on Grand Ave. A chemical laboratory will be installed in same. Estimated cost, $450,000. Scott & Mayer, Colby-Abbot Bldg., archts. and engrs.

TWO RIVERS—The Bd. Educ. will soon award the contract for the construction of a 3-story, 80x155-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $400,000. J. D. Chubb, 109 North Dearborn St., Chicago, Ill., archt.

Ontario

BROCKVILLE—The Provincial Bd. of Health plans to construct a filtration plant. Estimated cost, $50,000.

PEMBROKE—The McGuire, Patterson & Palmer, Ltd., 343 Dorchester St. W.., Montreal, has awarded the contract for the construction of a match factory, to Fraser Brace & Co., Ltd., 83 Craig St., W., Montreal. Estimated cost, $5,000,000.

PORT DALHOUSIE—The city has awarded the contract for the construction of a sewage disposal system, etc., to R. M. Smith, 58 Howard St., Toronto. Estimated cost, $45,000.

ST. CATHERINES—The Kinleth Paper Co., Welland Canal, has awarded the contract for the construction of a 2-story addition to its paper factory, to the Tremble Co., Thorold St. Estimated cost, $25,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS is holding its winter meeting at New Orleans, Dec. 6 to 9. Headquarters are at the Hotel St. Charles.

AMERICAN PHYSICAL SOCIETY will hold its annual meeting, beginning Dec. 28, at Chicago, it being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies Building from Dec. 7 to 10 inclusive.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25 Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.